POWER

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A Problem

WHO GETS THE PROMOTION?

Detroit's Municipal Lighting Plant

By Thomas Wilson

SYNOPSIS—Beginning in a small way in 1895, the plant now has a capacity of 11,450 kw. to supply all lighting for streets, parks and public buildings. Last year the output was 15,677,255 kw.-hr. and the operating cost 0.641c.

A decidedly successful municipal station is the public lighting plant of Detroit. In operation nearly 20 years, each annual report has shown a reduction in the cost per unit output and in the annual charge per lamp for current and attendance. The plant and line equipment have been kept in good repair and additions to the generating capacity have been made as the increasing load required.

lighting plant were put in service in April, 1895, and the lighting of the city by the municipal plant began Oct. 1 of the same year.

The cost per lamp for operation and maintenance—not including fixed charges such as interest, depreciation, etc., for the year ending June 30, 1896, was $68.52. The same cost for the year ending June 30, 1914, was $25.21. The greater part of this reduction has been made possible by the substitution of modern and more efficient apparatus for the equipment originally installed. As shown in Table 1, it has been gradually effected from year to year, showing that efforts in this direction were unremitting.

The plant was built for a capacity of 2000 arc lamps.

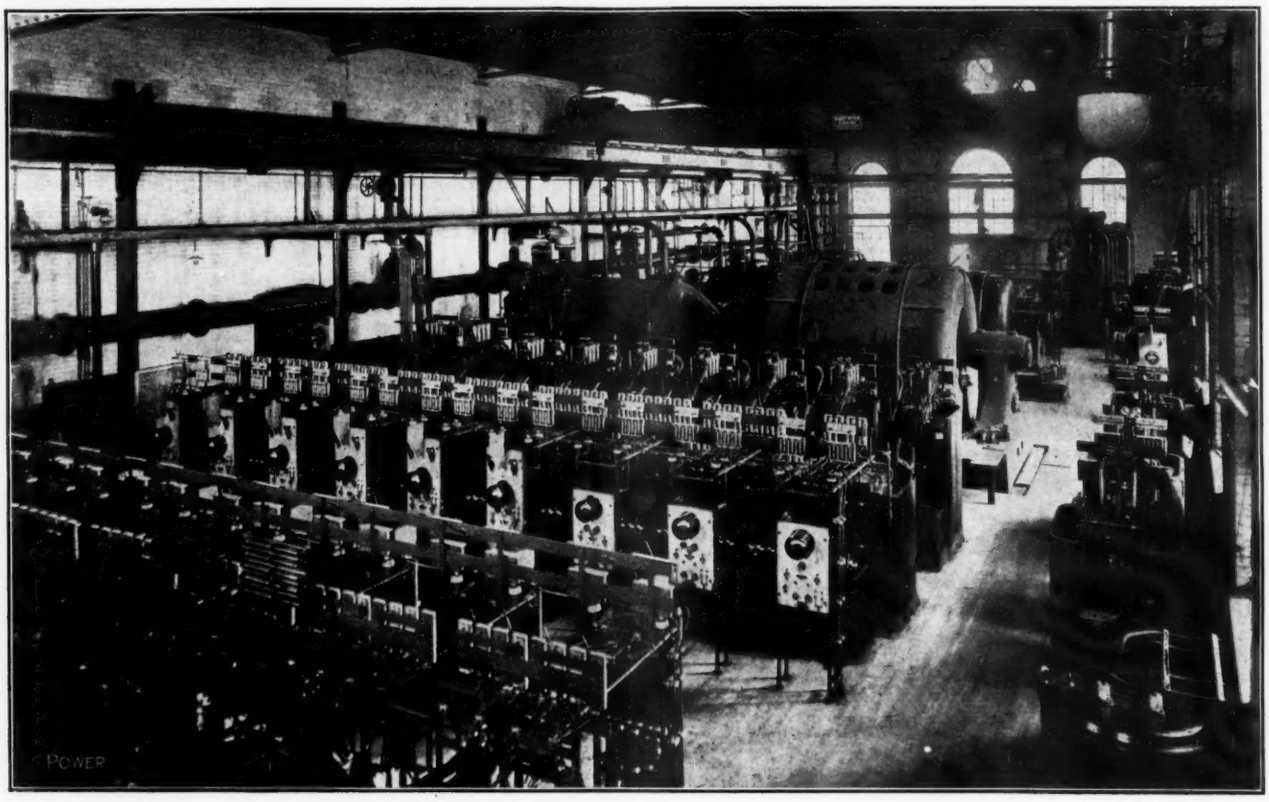


Fig. 1. Generating Room of the Public Lighting Plant

Later types of prime mover and generator replaced the older units until now the load is carried by horizontal reaction turbo-generators at an operating cost of 0.64c. per kw.-hr.

It may not be generally known that Detroit was one of the first cities to adopt the electric arc lamp for street lighting. The first contract was made in 1883 for 22 arc lamps, at 50c. per lamp per night, operated on a moonlight schedule. The next year, in 1884, a contract was made for 300 arc lamps on an all-night schedule. The contract price was $95,000 for the year, or $316.67 per lamp. Following contracts somewhat reduced the rate, but the lowest was $132.41 for each lamp for the year. This was found to be higher than was paid in many other cities. For this reason, and because the service was unsatisfactory, the citizens of Detroit decided to build a municipal plant. The first lamps operated from a public

Five marine-type engines belted to twenty 50-kw. arc dynamos and three 57½-kw. direct-connected arc dynamos furnished the electrical energy. This equipment practically filled all the available floor space in the engine room. Today, with an extension of only 16 ft. to the engine room, the generating capacity consists of two 600-kw., two 2000-kw. and one 6250-kw. units. The two 600-kw. generators are connected to reciprocating engines, one of the Willans three-line, triple-expansion type and the other a

TABLE 1—ANNUAL COST PER ARC LAMP

Fiscal year ending June 30,		Fiscal year ending June 30,	
1896	$68.52	1906	$33.18
1897	64.19	1907	33.25
1898	51.85	1908	34.65
1899	46.46	1909	32.17
1900	40.30	1910	30.34
1901	42.59	1911	29.93
1902	39.45	1912	27.10
1903	41.03	1913	25.49
1904	40.16	1914	25.21
1905	34.99		

triple-expansion, marine-type engine. The two 2000-kw. generators are driven by horizontal reaction turbines served by barometric condensers, each having a capacity to condense 50,000 lb. of steam per hour. These machines have been carrying the bulk of the load, which has now reached the limit of their capacity. For protection against shutdown another unit was badly needed, and a substantial increase in the number of arcs for the coming year made additional generating capacity imperative. A new turbine unit, of the semi-double-flow type and rated at 6250 kw. at 70 per cent. power factor, has just been installed. It will be served by a surface condenser having 8000 sq.ft. of cooling surface, or 1.28 sq.ft. per kilowatt of generator rating. With steam at 160 lb. gage and 100 deg. of superheat and cooling water at 40 deg., the guaranteed steam consumption per kilowatt-hour is 13.15 lb.; with 70 deg. water the rate increases to 13.9 lb.

In the boiler room the old 300-hp. boilers with hand-fired furnaces are being gradually replaced by larger boilers with modern stokers. There are now five 400-hp. water-tube boilers and five 300-hp. boilers. Three of the smaller capacity have just been removed and within the year they will be replaced by three larger boilers. The present capacity then is 3500 boiler horsepower. The new units will add 1200 hp., giving a ratio of 1 boiler horsepower to 2.43 kw. of generating capacity. A coal conveyor raising the fuel to overhead bunkers has been in operation for about two years.

These improvements in the boiler and engine rooms can be checked from one year to another by the reduction in consumption of coal per unit output. In 1908 the coal burned per kilowatt-hour averaged 5.23 lb.; last year's records show 3.42 lb. per unit, a reduction of more than 34 per cent. Table 2 gives the average monthly figures for the last six months. During this time the grade of coal used has been approximately the same. All coal is purchased on a penalty basis. This year's contract for West Virginia nut, pea and slack, on a contract guarantee of 14,143 B.t.u. per lb., is on the basis of $2.25 per ton, delivered on the siding of the plant.

About as good a showing has been made in reduction of costs in other directions. The trimming of the Brush arc lamps, which in 1898 cost $16.54 per lamp, per year, for carbons, globes and labor, was reduced to $3.98 per lamp when series alternating-current arcs replaced the Brush lamps; it was again reduced to an average of about $2.06 per lamp per year for the 4-amp. luminous arcs, which are gradually replacing the series alternating-current lamps. Of the latter there are only 2337 in operation, and these are in the outlying districts of the city.

TABLE 2—COMPARATIVE AMOUNT OF COAL CONSUMED

Year ending June, 30,	Lb. Coal Consumed	1914 Lb. per Kw.-Hr.	1913 Lb. per Kw.-Hr.	1912 Lb. per Kw.-Hr.	1911 Lb. per Kw.-Hr.	1910 Lb. per Kw.-Hr.	1909 Lb. per Kw.-Hr.
July	3,257,054	3.50	3.59	3.88	4.40	5.19	4.64
August	3,377,501	3.29	3.30	3.60	4.10	4.98	4.61
September	3,637,994	3.12	3.45	3.43	3.90	4.72	4.63
October	4,817,727	3.36	3.33	3.27	3.92	4.39	5.30
November	5,511,982	3.60	3.88	3.26	3.49	4.23	4.32
December	6,070,874	3.65	3.63	3.24	3.49	4.22	4.53
January	5,492,912	3.26	3.43	3.49	3.25	4.31	4.70
February	4,894,079	3.47	3.61	3.64	3.50	4.47	4.90
March	5,067,349	3.55	3.27	3.42	3.38	4.63	5.07
April	4,438,862	3.58	3.52	3.20	3.51	4.91	5.19
May	3,889,917	3.38	3.53	3.42	3.76	4.93	5.10
June	3,325,194	3.29	3.55	3.29	4.07	4.74	5.22
Totals	53,781,445	3.42	3.51	3.43	3.68	4.59	4.84

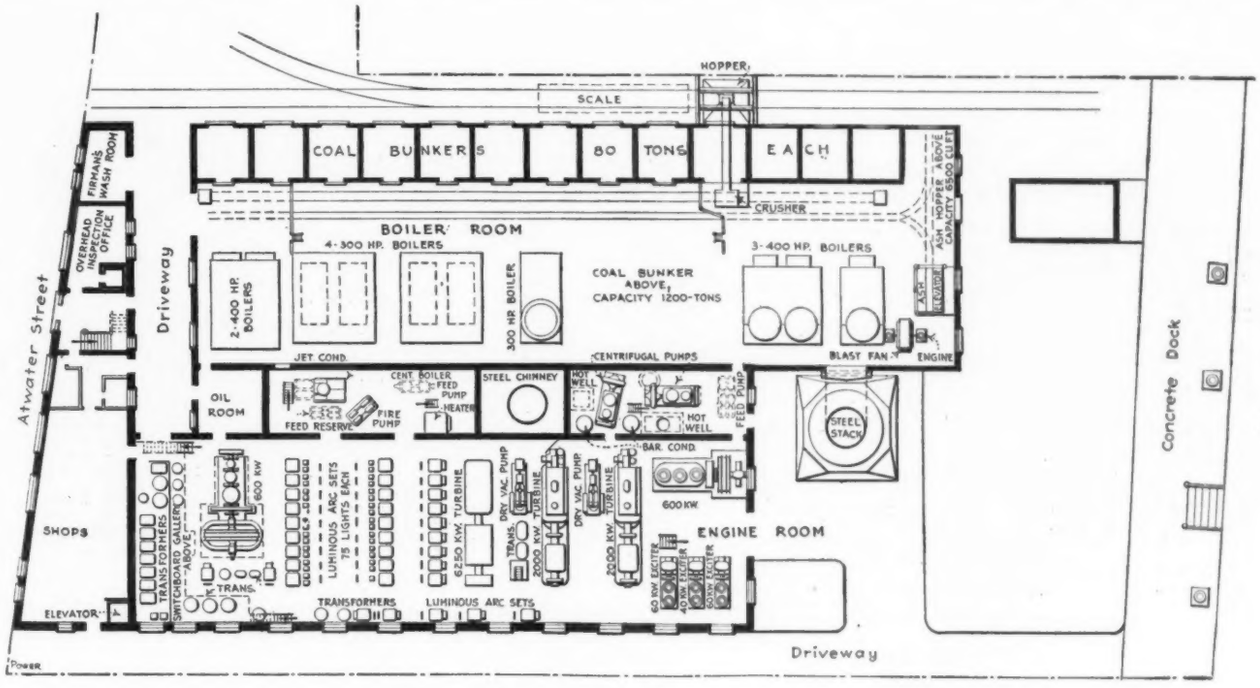


FIG. 2. GENERAL PLAN OF THE STATION

At present 7376 arc lamps are in service and about 1500 more will be added during the year. The time of lighting for the year ending June 30, 1914, totaled 3917 hr. 10 min., and the average per night was 10 hr. 42 min. The average number of arcs operated during the year was 6684. The lamp-hours scheduled were 27,101,524 and the lamp-hours out, due largely to line, lamp and station troubles, were 50,494, a ratio of only 0.18 of 1 per cent.

In addition to the arc lighting, service is supplied to more than 200 public buildings, including school houses, fire-department engine houses, police stations, libraries, public parks, etc. This also includes service for a con-

nected load of 1427 hp. in motors and more than 30,000 incandescent lamps.

Last year the output was 15,677,255 kw.-hr., divided between arcs and incandescents, as shown in Table 3;

TABLE 3—COMPARATIVE KILOWATT-HOUR OUTPUT
(Twelve months to June 30, 1914)

	Arc	Incandescent	Total
July	759,041	171,434	930,475
August	856,499	170,481	1,026,980
September	962,138	205,797	1,167,935
October	1,127,833	304,932	1,432,765
November	1,219,437	313,113	1,532,550
December	1,327,618	335,272	1,662,890
January	1,325,199	360,501	1,685,700
February	1,113,313	296,587	1,409,900
March	1,117,665	309,375	1,427,040
April	986,070	255,360	1,241,430
May	920,976	228,934	1,149,910
June	827,210	182,470	1,009,680
Totals	12,542,999	3,134,256	15,677,255

under the latter heading motors are included. The cost of operating the plant is given in detail in Table 4 for the year ending June 30, 1914, and the totals for four years. The total operating expense is divided under the various heads of maintenance, executive, station, lighting and some miscellaneous items. The division referring to the station operating expense is naturally of the greatest interest, as these data are directly comparable with statistics from any type of generating plant. The fuel cost per unit of output forms a good basis on which to judge the economy of the plant. In the present instance a charge of 0.393c. per kw.-hr. may be considered excellent. The wages add 0.232c., supplies 0.013c. and oils 0.003c. A total operating expense of 0.641c. per kw.-hr. compares favorably with the best of privately owned plants, and this good showing was made during a period of reconstruction. With the large unit carrying the load and being supplied with steam from the boilers equipped with stokers, a reduction in the operating expense may be expected.

Adding the other items to the operating expense gives a total of 1.45c. per kw.-hr. A comparison with other years shows that there has been a gradual reduction, except that the unit cost for 1913 is just a shade lower than for the present year.

From the inauguration of the plant up to June 30, 1914, $2,847,567.80 has been expended for the building and site and the plant equipment, substations and line: The amounts charged off for depreciation, etc., lower this to $2,102,984.30. In round numbers the value of the station proper is $767,000, or $67 per kw. of rated generating capacity. This includes the building and the site but no part of the equipment of the line or the substations.

To make the generating cost comparable with other plants, it would then be necessary to add to the operating expense of 0.641c., given in Table 4, a 12 per cent. charge on the investment to cover interest, depreciation, insurance and taxes. The city, of course, does not pay taxes on its own property and other plants do. On $767,000, a yearly charge of 12 per cent. amounts to $92,040, and dividing by the output, the total reduces to 0.58c. per kw.-hr. Adding the operating and fixed charges, the total cost per kilowatt-hour is 1.22c.

The plant is favorably located on the river bank, about half-way between the east and west limits of the city. Coal and carload lots of supplies are delivered directly into the station yard over a spur track.

All electrical energy is generated at 2300 volts, two-phase. For outlying districts this voltage is raised to 5500 and 6600 volts and distributed to five substations (about 3½ miles from the main station), from which the several arc circuits for the respective districts are carried.

The wages of the help are about the same as those paid by Detroit private corporations for the same service.

TABLE 4—COST OF OPERATING PLANT, FISCAL YEAR ENDING JUNE 30, 1914

Output this year ending June 30, 1914.... 15,677,255 kw.-hr.
Output last year ending June 30, 1913.... 13,787,975 kw.-hr.

	Wages	Stores	Total	Cost per Kw.-Hr.
Maintenance—				
Buildings, track, dock, etc.	$1,830.05	$3,079.90	$4,909.95	.....
Steam plant	4,306.23	3,490.99	7,797.22	.....
Electric plant	1,753.49	947.39	2,700.88	.....
Miscellaneous tools and machinery	894.82	1,770.61	2,665.43	.....
Conduits	909.20	527.42	1,436.62	.....
Towers and lamp posts	2,934.30	524.23	3,458.53	.....
Arc lamps and switches	5,563.75	2,667.88	8,231.63	.....
Lines and cables	19,093.88	10,216.19	29,310.07	.....
Total maintenance	$37,285.72	$23,224.61	$60,510.33	$0.00385
Executive—				
Salary secretary and city electrician	$8,000.00	.....	$8.000.00	.....
Printing and stationery	.....	$1,006.15	1,006.15	.....
Storeroom	3,205.57	71.10	3,276.67	.....
Office expense	6,123.86	381.12	6,504.98	.....
Superintendent and drafting	5,671.65	83.40	5,755.05	.....
Total executive	$23,001.08	$1,541.77	$24,542.85	$0.00157
Station—				
Oils	.....	$424.42	$424.42	$0.00003
Waste	.....	34.07	34.07	0.00000
Coal	.....	61,614.72	61,614.72	0.00393
Miscellaneous supplies	.....	1,982.28	1,982.28	0.00013
Wages	$36,448.50	.....	36,448.50	0.00232
Total station	$36,448.50	$64,055.49	$100,503.99	$0.00641
Lighting—				
Trimming and patrolling	$18,228.45	$313.82	$18,542.27	.....
Electrodes	.....	7,705.12	7,705.12	.....
Rectifier tubes	.....	1,848.10	1,848.10	.....
Incandescent lamp renewals	.....	3,945.73	3,945.73	.....
Incandescant lighting expense	958.24	576.33	1,534.57	.....
Globes	.....	2,530.74	2,530.74	.....
Miscellaneous supplies	.....	95.23	95.23	.....
Belle Isle Park	599.44	93.53	692.97	.....
Palmer Park	152.43	31.52	183.95	.....
Total lighting	$19,938.56	$17,140.12	$37,078.68	$0.00237
Shop supplies	.....	$24.90	$24.90	$0.00000
Surgeon and hospital	$330.93	582.05	912.98	0.00006
Relief fund	3,757.52	.....	3,757.52	0.00024
Total operating cost	$120,762.31	$106,568.94	$227,331.25	$0.01450
12 months to June 30, 1913	$108,036.66	$90,479.77	$198,516.43	$0.01440
12 months to June 30, 1912	102,080.00	85,732.96	187,813.05	0.01538
12 months to June 30, 1911	99,396.37	80,171.52	179,567.89	0.01686
12 months to June 30, 1910	91,022.46	80,238.65	171,261.11	0.01710

The working day is eight hours. Every year ten days' vacation with pay is given to each employee. In case of injury while on duty, all expenses for medical attendance are paid by the commission, and full pay is given to the injured employee during the time that he is incapacitated. That conditions are agreeable to the workmen is proved by the fact that in every department there are employees who helped in the construction and first year's operation of the plant.

That the municipal plant of Detroit is a success is due to the ability of Frank R. Mistersky, general superintendent, and to the caliber of the men who have served as public lighting commissioners. Some of Detroit's most eminent citizens have considered it an honor to be able to serve the city and have given liberally of their valuable

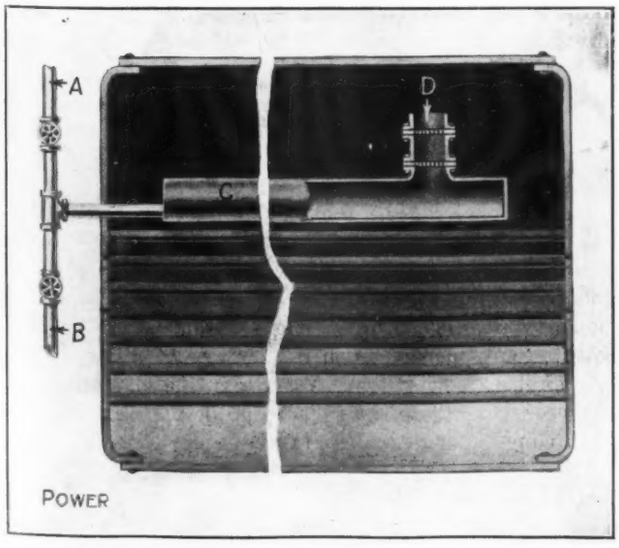
PRINCIPAL EQUIPMENT OF DETROIT PUBLIC LIGHTING PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
4	Boilers	Double deck tubular	300 hp.	Generate steam	160 lb. pressure, hand fired	Sharkey & Peck
4	Furnaces	Down-draft	46 sq.ft.	Serving Peck boilers		Hawley Down Draft Furnace Co.
1	Boiler	Vertical water-tube	300 hp.	Generate steam	160 lb. pressure	Wickes Boiler Co.
1	Stoker	Detroit	56 sq.ft.	Serving Wickes boiler		Detroit Stoker Co.
3	Boilers	Vertical water-tube	400 hp.	Generate steam	160 lb. pressure, 100 deg. superheat	Wickes Boiler Co.
3	Stokers	Underfeed	Projected area 43.5 sq.ft.	Serving Wickes boilers		American Engineering Co.
2	Boilers	Stirling	400 hp.	Generate steam	160 lb. pressure	Babcock & Wilcox Co.
2	Stokers	Underfeed	Projected area 43.5 sq.ft.	Serving Sterling boilers		American Engineering Co.
3	Superheaters	Foster		On 400-hp. Wickes boilers	100 deg. superheat	Power Specialty Co.
1	Coal conveyor	Bucket	40 tons per hr.	Raise coal to bunkers		Link Belt Co.
1	Track scales	5 section	100 ton	Weigh incoming coal		Fairbanks Morse & Co.
1	Pump	Duplex	10x5x10-in.	Feed boilers	160 lb. steam	Henry R. Worthington
1	Pump	Duplex	14x8½x10-in.	Feed boilers	160 lb. steam	Henry R. Worthington
1	Pump	Duplex	10x7x15-in.	Feed boilers	160 lb. steam	Platt Iron Works Co.
1	Pump	Three - stage centrifugal	300 gal. per min.	Feed boilers	Driven by Kerr turbine	Jeanesville Iron Works Co.
1	Pump	Duplex	1000 gal. per min.	Fire pump	160 lb. steam	Henry R. Worthington
1	Heater	Receiver type	3500 hp.	Boiler feed water	Exhaust steam from aux.	Harrison Safety Boiler Works
2	Turbo-alternators	Alternating-current	2000 kw.	Main units	Two-phase, 60-cycle, 2300 volts, 1200 r.p.m.	Westinghouse Machine Co.
2	Condensers	Barometric	50,000 lb. steam per hr.	Serving 2000 kw. units		Alberger Pump & Condenser Co.
2	Pumps	Centrifugal	100 gal. per min.	Serving barometric condensers	Driven by Westinghouse vert. comp'd engine	Alberger Pump & Condenser Co.
2	Pumps	Hor. dry vacuum	12x22x18-in.	Serving barometric condensers		Alberger Pump & Condenser Co.
1	Turbo-alternator	Alternating-current	6250 kw.	Main unit	Two-phase, 60-cycle, 2300 volts, 1800 r.p.m.	Westinghouse Machine Co.
1	Condenser	Surface	8000 sq.ft.	Serving 6250-kw. unit		Westinghouse Machine Co.
1	Pump	Centrifugal	8000 gal. per min.	Circulating cooling water	Driven by Westinghouse turbine	Westinghouse Machine Co.
1	Pump	Centrifugal	7-in. discharge	Air pump	Driven by Westinghouse turbine	Westinghouse Machine Co.
1	Pump	Centrifugal	6-in. discharge	Condensate pump	Driven by Westinghouse turbine	Westinghouse Machine Co.
1	Marine engine	Triple-expansion	17x27x46x30-in.	Main unit	160 lb. steam, vac. 26 in., 120 r.p.m.	S. F. Hodge & Co.
1	Generator	Induction	600 kw.	Direct connected to Marine eng.	Two-phase, 2200 volt, 120 r.p.m.	Stanley
1	Engine	Three - line triple-expansion	13 7/16 x 20 7/16 x 32 x 13 7/16-in.	Main unit	160 lb. steam, 26-in. vac., 277 r.p.m.	Willans
1	Generator	Induction	600 kw.	Direct connected to Willans eng.	Two-phase, 2200 volt, 277 r.p.m.	Stanley
1	Condenser	Jet	50,000 lb. steam per hr.	Serving two 600-kw. units		Henry R. Worthington
1	Exciter	Eng. driven	60 kw.	Excitation of main units	Driven by 100-hp. Willans eng., 450 r.p.m.	Northern Electric
1	Exciter	Eng. driven	40 kw.	Excitation of main units	Driven by 100-hp. Willans eng., 325 r.p.m.	Northern Electric
1	Exciter	Eng. driven	60 kw.	Excitation of main units	Driven by 100-hp. Willans eng., 450 r.p.m.	Westinghouse Electric & Mfg. Co.

time and ability. The present board of commissioners includes J. J. Barlum, president; Charles H. Bryan, vice-president; J. T. Lynn, J. F. Lewis, Fred Guenther and George Burns.

Mechanical Scale Preventer

What has been designed to be a simple, practical, low-cost, automatic method of preventing scale formation in steam boilers is illustrated herewith. It is manufactured by the Mechanical Scale Prevention Co., 105 Chambers St., New York City.



SECTION THROUGH SCALE PREVENTER

The device consists of a tube *C*, at one end of which is the filter chamber *D*. This is made with a perforated plate next to the two flanges of the thimble. The space between the two perforated plates is filled with filtering material. The apparatus is placed in the top or the bottom of the horizontal return-tubular boilers or in the steam drums of water-tube boilers. It is in sections and no change in piping is necessary when putting it in a boiler.

The feed water enters through the pipe *A* and passes into the heater and settling chamber *C*, where the water is heated sufficiently to precipitate the solids. The water minus the impurities passes through the filter *D* into the boiler at nearly steam temperature.

As the preventer is in contact with water only, the solids do not bake or harden to the shell; they are removed through the blowoff *B*. This is done by closing the valve in the supply pipe *A* and by opening the one in the blow-down pipe *B*, which produces a reverse pressure on the filtering material and blows out whatever sediment has been collected by the filter in the precipitating and heating chamber *C*.

Large Testing Transformer—Two students of the University of Washington have undertaken the construction of what is said to be the largest testing transformer on the Pacific Coast, as a thesis for a degree in engineering. They are Leo Dashley and Joan Dodds, both Seattle men. The transformer, which will be ready for use in the spring, will be surpassed only by those in the testing laboratories of some of the big electrical companies. The apparatus is to be set up in the engineering building for research work and the testing of insulating materials. It will be 7 ft. high, 4 ft. wide and 2 ft. thick; will contain 300 lb. of wire; and will step up the voltage from 220 to 220,000.

The Power-Factor Indicator

By John A. Randolph

SYNOPSIS—Principle of the power-factor meter and its operation on single-, two- and three-phase circuits.

The power-factor indicator or meter is an instrument for obtaining readings of the power factor of a circuit together with an indication as to whether the current is lagging or leading. Such an instrument is necessary in stations equipped with alternating-current machinery in order that the excitation of the machines may be so regulated as to secure at all times the maximum efficiency in the operation of the system. They are also connected to feeders for an indication of the power factor on the various parts of the distribution system.

As ordinarily constructed, the power-factor indicator consists of two sets of coils. One set, called the current coils, is connected to the secondary side of one or more current transformers in the power lines; the other set, known as the voltage coils, being connected either directly across the lines or to the secondaries of potential transformers; the latter are always used on high-tension lines.

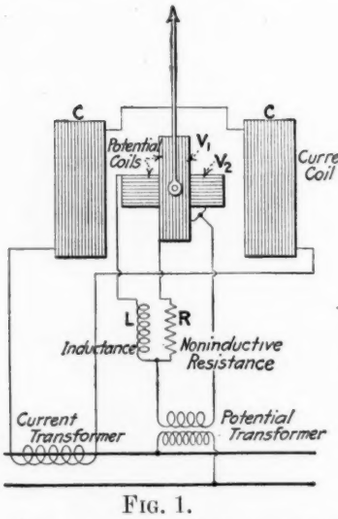


Fig. 1.

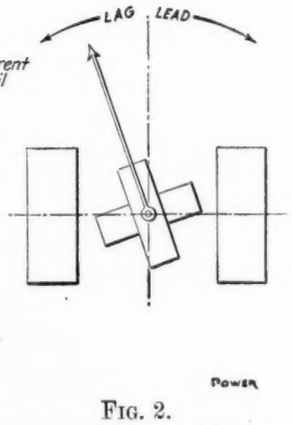


Fig. 2.

Illustrating Principle of Single-Phase Power-Factor Meter

In one type of instrument the voltage coils are movable and are set upon the scale pointer shaft with axes in the same plane but at an angular displacement, depending upon the number of coils used. The shaft with its coils is free to move, inasmuch as it is not restricted by springs or weights. While the coils of the movable element are so arranged and connected as to produce a rotating field, the current coils are stationary and may produce either a fixed or rotating field, depending upon whether there is one coil connected to one phase or two or more coils connected to more than one phase.

Single-Phase Meter

The fundamental connections and elements of a single-phase instrument of this type are represented in Fig. 1, in which V_1 and V_2 are two voltage coils comprising the movable element. They are placed at right angles to each other on the pointer shaft. One of the coils, V_1, is connected across the lines or transformer secondary through a non-inductive resistance R, the other, V_2, being connected to the same source but through an inductance L. Inasmuch as the resistance R is noninductive, the current passing through V_1 will be in phase with the line voltage; that in V_2, however, will lag behind the line voltage owing to the inductance L. The latter is generally calibrated to cause the current in V_2 to lag 90 deg. behind that of V_1. As a result of this phase difference, the current in V_1 will be at its maximum when that of V_2 is zero, and *vice versa*. The resultant magnetic field of the two coils will rotate similarly to the field of an induction motor.

When the voltage is in phase with the line current, the magnetic field of V_1 will reach its maximum at the same instant as that of the stationary current coils C, the field of V_2 passing through zero at the same time. Moreover, when the field of V_2 is at its maximum, that of the current coils will be a minimum. No turning moment, therefore, will be exerted upon the voltage coils. However, when the line current is out of phase with the voltage, the currents in the coils V_1 and C will reach their maxima at different times. Furthermore, the current in V_2 will no longer be at zero simultaneously with the maximum of the current in coils C, but will exert a force upon the field of coils C depending in intensity upon the difference in phase between the line current and the voltage. The action of the field of the current coils upon the resultant field of V_1 and V_2 will serve to turn the latter away from the position shown in Fig. 1 to one such as shown in Fig. 2, the angle of deflection depending upon the lag or lead of the line current. The pointer at one end of the shaft of the movable element registers the extent of the deflection upon a scale calibrated to give direct readings either of the power factor corresponding to the deflection or of the phase difference in degrees between voltage and current. It also shows whether the current is leading or lagging by swinging to the right or left of the unity point on the scale. When the current in coil V_1 is in phase with the line current in coils C, the power factor of the circuit will be unity and will be so indicated by the pointer.

Polyphase Meter

The principle of operation for these instruments is the same as for the single-phase type. However, the arrangement and connections of the coils are different owing to the additional phases. No inductance is used for phase splitting in connection with the potential coils, inasmuch as the phase difference necessary for the rotating field of these coils is secured by connecting the latter directly across the line phases. The number and angular spacing of the potential coils depend upon the number of phases in the line circuit. On two-phase systems the potential element consists of two coils placed 90 deg. apart, whereas, on three-phase systems there are three star-connected coils placed 120 deg. apart. On balanced systems, only one current coil is necessary, but on unbalanced systems more must be used. On the unbalanced three-phase system three current coils are necessary in addition to the three potential coils in order that the variation in the strength

of the line currents may be taken into account. In such an instrument, the fields of both sets of coils are rotating and their resultant effort on the movable element will cause it to move the pointer to a position corresponding to the power factor of the circuit as in the single-phase type.

Fig. 3 is a diagram of connections for a power-factor indicator on a two-phase circuit. It will be observed that there is but one current coil and that this is excited from only one of the phases, this being a common practice on balanced systems. However, on unbalanced systems such a connection would not give the average power factor of the circuit as a whole, but of only one of the phases. For that reason, for accuracy, it is necessary to use instruments with two or more current coils excited from current transformers so connected in the lines as to furnish an indication relative to the current flowing in all the phases. On systems whose load is made up of polyphase motors and converters, a balanced condition exists; therefore, on such circuits, power-factor indicators taking current from only one line are generally used.

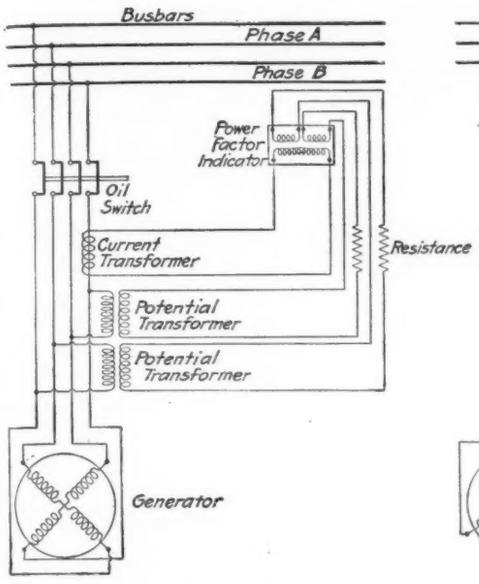


FIG. 3. TWO-PHASE CONNECTIONS FOR BALANCED SYSTEM

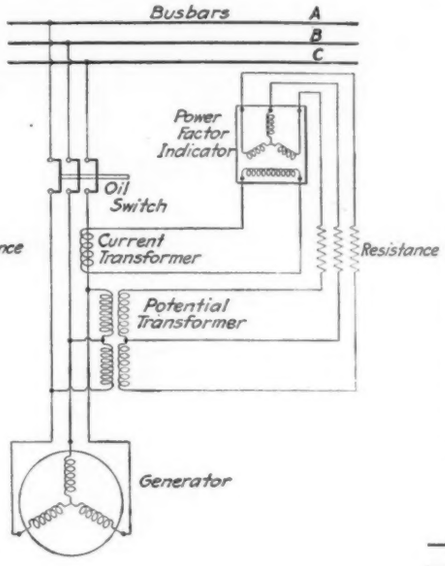


FIG. 4. THREE-PHASE CONNECTIONS FOR BALANCED SYSTEM

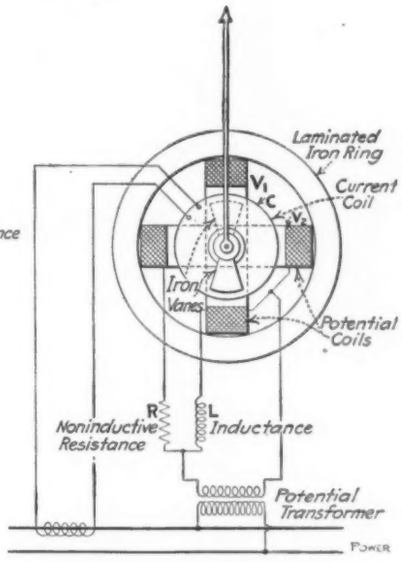


FIG. 5. MOVABLE-VANE TYPE OF METER

A noninductive resistance is generally placed in series with each potential coil lead for purposes of calibration and current regulation. In Fig. 5 are shown the connections for a three-phase indicator as used on a balanced system.

MOVABLE-VANE TYPE

This instrument operates in a similar manner to those already described, but all of its coils are stationary. The movable element consists primarily of two iron vanes or armatures attached to the pointer shaft and extending radially in opposite directions as shown in Fig. 5. In the single-phase type there are two voltage coils V_1 and V_2, with axes at right angles to each other, and one current coil C whose plane coincides with that of the axes of the voltage coils. The connections of the voltage coils are similar to those of Fig. 1, one coil being connected across the line through a noninductive resistance and the other through an inductance, the currents in the two coils consequently being in quadrature. Therefore, the resultant magnetic field is rotary. Under the influence of the field of coil C, the iron vanes act as the magnetic poles of an electro-magnet and will therefore be turned in response to the action of the flux from the voltage coils V_1 and V_2.

If the line current is in phase with the voltage, the currents in coils V_2 and C will reach their maxima at the same instant, the current in coil V_1 then being at zero because of its set relation to that of coil V_2. The vanes will then take a position parallel with the axis of coil V_2 as shown, and the pointer will indicate unity power factor on the scale. If, however, the line current is out of phase with the voltage, the current in V_1 will no longer be at zero when that of C is at its maximum, but will have a value, at that instant, depending upon the phase difference between the line current and the voltage. It will, therefore, act with coil V_2 in exerting a turning force upon the iron vanes. The latter will be shifted to a point where equilibrium will be reached between the magnetic fields of the current and voltage coils, the pointer then indicating the power factor at this particular instant. The function of the laminated iron ring is to form a low-resistance path for the magnetic flux of the rotating field thus rendering the latter stronger and more efficient.

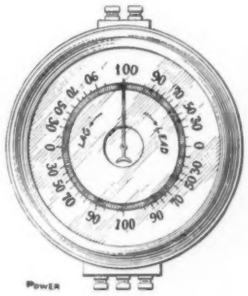


FIG. 6. CIRCULAR DIAL TYPE

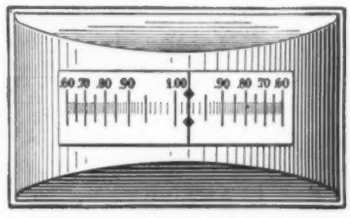


FIG. 7. HORIZONTAL EDGEWISE TYPE

In the polyphase instrument of this type the positions of the current and voltage coils are interchanged from that shown in Fig. 5, the rotating field being then pro-

duced by the current coils instead of by those on the voltage circuit. In the two-phase meter there are two current coils which are placed 90 deg. apart, and in the three-phase instrument, the three coils are placed 120 deg. apart.

Construction and Installation

The power-factor indicator is made in both the circular and horizontal edgewise patterns, the circular type being shown in Fig. 6. The directions which the pointer will take on leading or lagging currents are indicated by arrows marked accordingly. The scale gives readings from zero to one hundred, thus enabling any percentage of power factor to be read.

The horizontal edgewise indicator is shown in Fig. 7. The dial of the instrument is curved cylindrically, but the scale divisions are vertical and the pointer maintains a constantly vertical position. The pointer swings to right or left depending upon whether the current is leading or lagging, and the scale records power-factor readings from 60 per cent. to unity, this covering the range ordinarily encountered.

The resistances used in connection with the voltage coils of the various types are separate from the instrument and are usually in a convenient position on the back of the panel. They are contained in a small rectangular sheet-iron box so constructed as to allow free ventilation and ready access.

Underfeed Stokers*

By Osborn Monnett†

SYNOPSIS—Headroom is the principal factor with these stokers. For smokeless operation no special brickwork is required. Their application to different types of boiler and instructions for operation are given.

The application of underfeed stokers to nearly all types of boiler is simple and no preparation in the form of arches or brickwork construction of any kind is required. Fig. 1 shows a 72-in. by 18-ft. boiler served by an American stoker. From the dead plate to the boiler shell the measurement is 42 in. With a similar boiler the standard height for Jones stokers varies from 36 to 42 in.

Fig. 2 is a typical installation of a Jones stoker and a

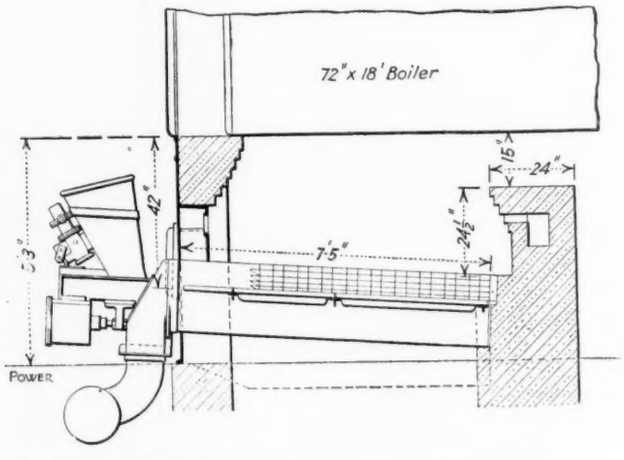


Fig. 1. American Stoker under Return-Tubular Boiler

return-tubular boiler. This stoker may be easily applied to a water-tube boiler when the baffles are horizontal. If desired, a T-tile can be used over the fire to any extent to increase the heat absorption. Fig. 3 shows such an installation consisting of an Oil City water-tube boiler and a Jones stoker; this arrangement is working out satisfactorily. The headroom in this instance is 6 ft. 3 in. from the floor line to the bottom of the front header and all the other dimensions are in proportion.

In the case of a B. & W. boiler with a Sewell baffle, Fig. 4, a similar setting would be used, but, due to the pitch of the tubes, the headroom would be 7 ft. When using the vertical baffle, care should be taken that sufficient flame travel is provided to avoid the dampening effect of the tubes on combustion. As in other stokers, the bank of tubes has a wonderfully dampening effect on the flame;

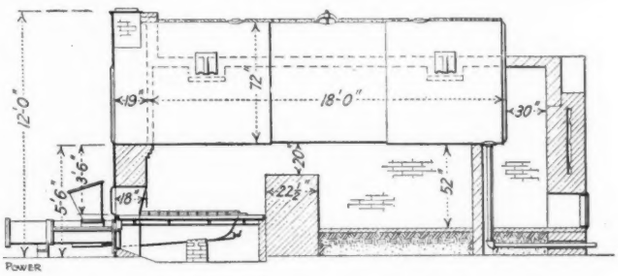


Fig. 2. Jones Stoker under Return-Tubular Boiler

if set too close to the fire, the boiler will show considerable No. 1 and No. 2 smoke. On vertically baffled boilers of the B. & W. type using American or Jones stokers, 8 ft. 6 in. should be the minimum distance from the floor to the bottom of the front header. Fig. 5 is typical and shows the proper dimensions. There is nothing special to be said regarding the application of the Jones stoker to Stirling boilers; the setting may be made flush front and the standard Stirling arch can be used, as in Fig. 6.

Operating American or Jones Stokers

Starting Fires—Fill the retort by means of the ram so that the tuyere blocks are covered with green coal. Scatter fire from another furnace along each side and at the center of the retort on top of the green coal. Start the blower slowly, increasing the speed as the fire builds up. If steam is not available to work the stoker, fill the retort with scoops and start a wood fire on top of the coal in the usual manner, leaving the doors cracked open to prevent smoke. Fire by hand until steam is raised to work the ram and blower.

Carrying the Load—Always carry a thick fire on the retort, from 14 to 24 in. After the load is on, the operation is automatic and is taken care of by the steam pres-

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†Smoke inspector, City of Chicago.

sure. When carrying a load, never throw in green coal on top of the fire as this will cause smoke.

Cleaning Fires—Clean the fires when the accumulation draft and close the fire-doors and damper. If the bank has been on for a considerable period, some clinker may form in the retort. When starting up remove this clinker

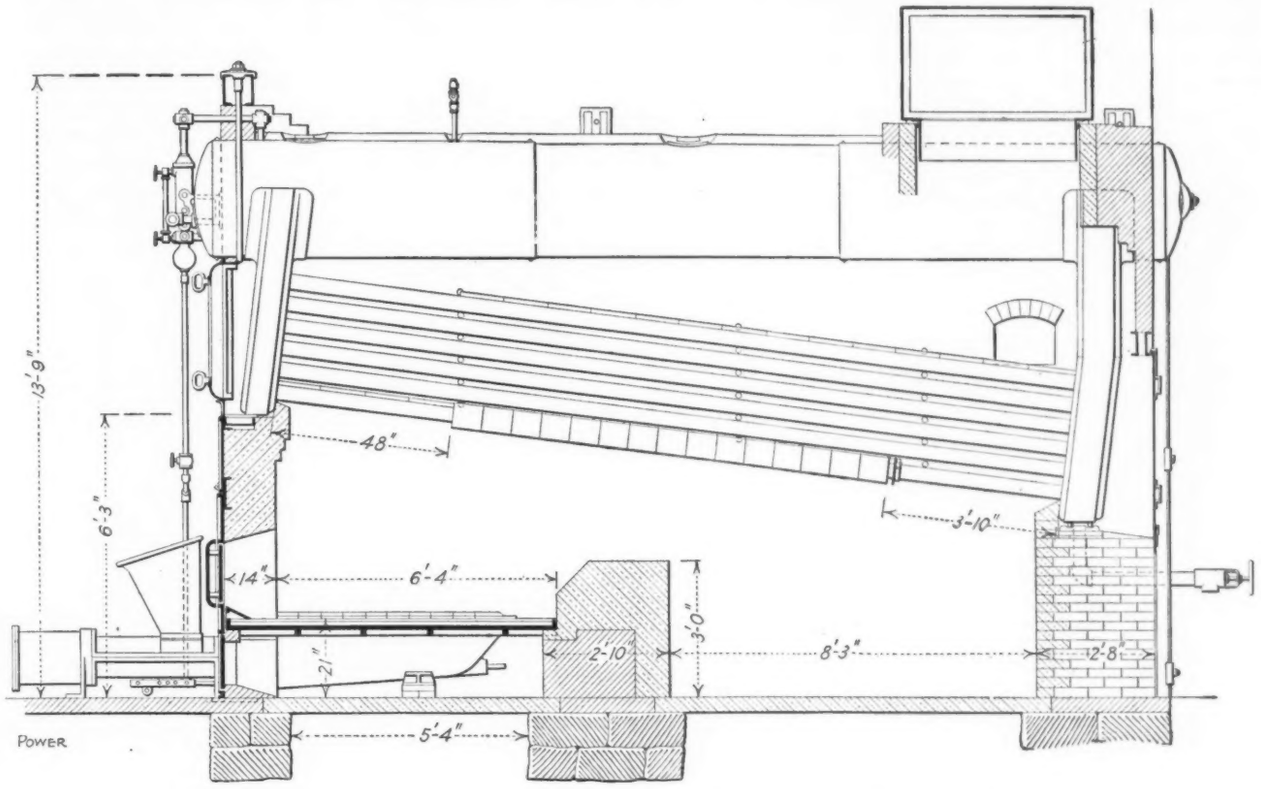


FIG. 3. JONES STOKER AND 130-HP. OIL CITY HORIZONTALLY BAFFLED BOILER

of clinker interferes with combustion. Lift the clinker from the dead plate with a slice bar and remove it through the front doors with a hook. Never clean so as to expose the dead plates to the intense heat of the fires. Let the ash and unconsumed coal remain on the side plates. Clean the dead plates and the top of the tuyere blocks only; the retort will keep itself clean. Shut off the forced draft when cleaning. Do not burn down the fire too thin before cleaning, and when cleaning, do not poke into the green coal as this will cause smoke.

Banking and Breaking Up Fires—Introduce several charges of coal by means of the ram, shut off the forced with a hook and break up the coked coal. The draft can then be turned on and the stoker started as usual.

TAYLOR STOKERS

This stoker is a development of the underfeed principle. There is a number of successful installations operating in the Middle West. While this stoker is not so well adapted to reconstruction jobs, especially where the boilers are set low, due to the headroom required for a successful installation, on a new job having plenty of headroom it is easily possible to get a good setting. Fig. 7 shows this stoker serving a B. & W. boiler set 9 ft. above the floor

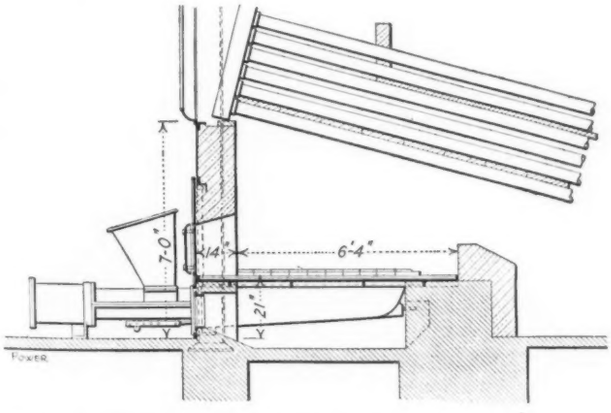


FIG. 4. BABCOCK & WILCOX BOILER, 134 HP., WITH T-TILE ROOF SERVED BY JONES STOKER

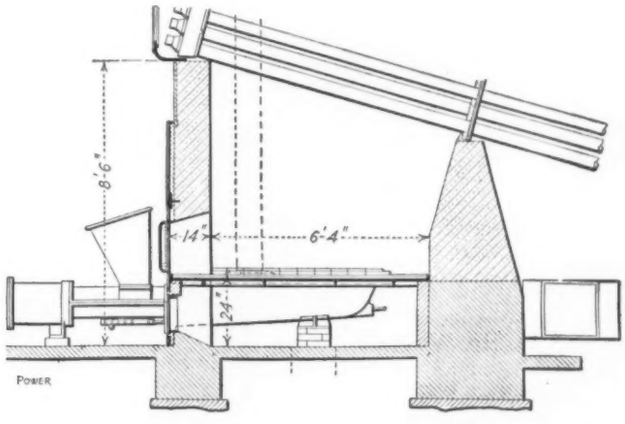


FIG. 5. JONES STOKER UNDER 134-HP. VERTICALLY BAFFLED BABCOCK & WILCOX BOILER

when measuring to the bottom of the front header. This outfit is running satisfactorily on Illinois bituminous coal. The flame travel is sufficient to allow thorough burning, and under loads up to considerably over rating the performance should be good. The capacity of the stoker to burn coal is limited only by the character of the refuse formed from that coal, and in turn the capacity of the stoker to free itself from this refuse. If the coal is

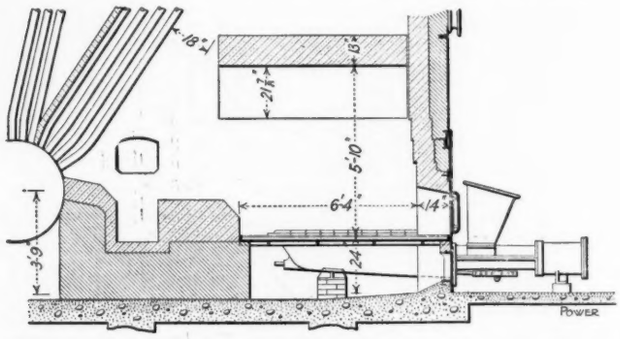


FIG. 6. STIRLING BOILER, 500-HP., SERVED BY THREE JONES STOKERS

such that the stoker can be run without working the fire from the side doors, there is little danger of smoke. The application of Taylor stokers to vertical boilers is simple. Fig. 8 shows a typical installation for a 500-hp. unit.

OPERATING TAYLOR STOKERS

Starting Fires—Feed in sufficient coal to cover the top tuyeres, then shut down the stoker and build a fire on this coal along the front wall, using clean kindling wood or live coal from another fire. Let this coal become thor-

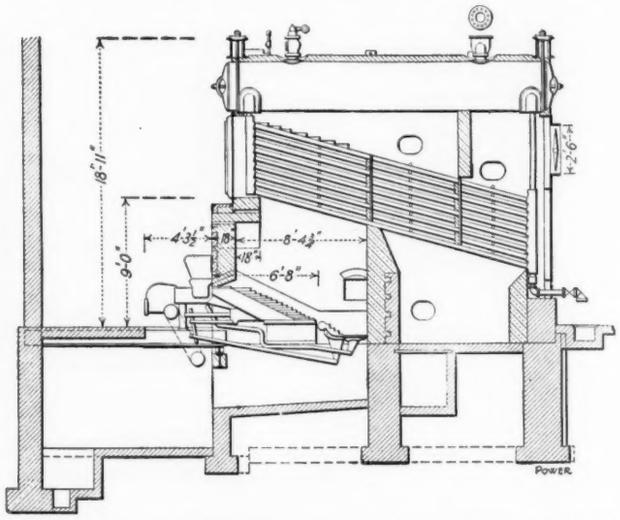


FIG. 7. TAYLOR STOKER UNDER BABCOCK & WILCOX 250-HP. VERTICALLY BAFFLED BOILER

oughly ignited by natural draft, then begin feeding a little more coal slowly, using a little forced draft, and gradually increase the feed and air pressure as the fire builds up.

There is no need to work the fires by hand except possibly to clean an occasional clinker from the side walls. The best time to do this is on a banked fire; if carefully done, there is no occasion for making any smoke.

At the time of dumping there should be no green fuel on or just above the dump plates. If smoke is made when dumping, it is caused by dislodging coal which has not had its volatile entirely distilled. Therefore, dumping and cleaning out should be confined to that refuse which lies directly on the dump plates. Leave the blast on while dumping and do not disturb the rest of the fuel bed.

Banking Fires—The fire is not cleaned previous to banking. When banking, the air is shut off and the coal in the hopper is fed in, leaving the hopper empty. One hopper full of coal will ordinarily carry a bank from 36 to 40 hr. For longer periods, a small amount of coal is fed in from time to time. The ashes may be dumped during the banking period.

In starting from a banked fire, first dump the ashes and then start the stoker running for a number of revolu-

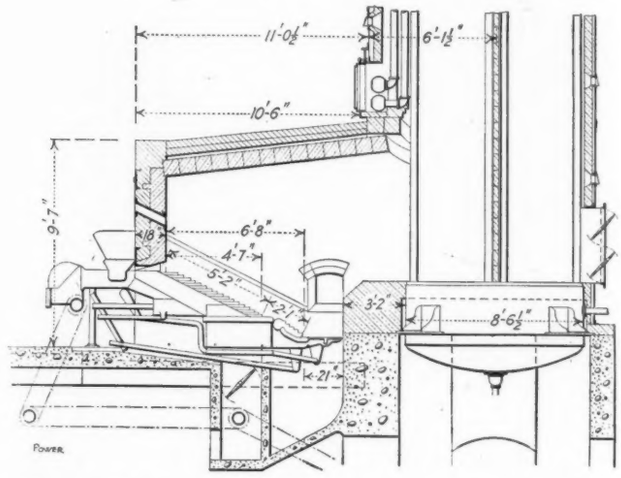


FIG. 8. WICKES 500-HP. BOILER AND TAYLOR STOKER

tions with the hopper empty. This will force the accumulation of ash onto the dump grate and give a clean fire, upon which coal can be fed in the usual manner.

Cement as Furnace Lining

To reduce the expense of boiler-furnace maintenance, the engineering department of the Robert Gair Co., Brooklyn, N. Y., has tried cement instead of firebrick or fireclay for lining the furnaces. The cement is of a 5 to 1 mixture of cement and hard-coal ash, with just a small part of sand, the latter being used sparingly, of course, because of the low temperature at which it melts.

The lining is 4½ in. thick on the side walls. The back arch is of concrete supported by T-irons, around which the concrete is poured. While one or two brick arches fell down, the concrete arches continue to give satisfactory service. In a neighboring plant settings of concrete were tried, but they failed.

It would be interesting if those who have tried cement and concrete for boiler settings would tell their experiences to POWER readers.

Power in Mining—The growing importance of mechanical power to the mining industry is shown by the fact that if mules alone were still relied on, the increased amount of power required in the last ten years would call for an additional investment of nearly eight million dollars in mules, not including replacing any that died during that period. As a matter of fact, the number of mules actually used decreased from 16,139 in 1902 to 15,187 in 1912, while the electric locomotives increased from 53 to 951 and the steam locomotives on the surface from 373 to 579.

Westinghouse Underfeed Stoker

An underfeed stoker has been developed by the Westinghouse Machine Co., Pittsburgh, Penn. It is designed to burn sufficient coal to evaporate three or more times the rated amount of water in a given boiler, and has been thoroughly tested in actual service. Its construction and operation will be understood by referring to Fig. 1, which shows the essential details.

Box girders *A* are bolted at their fronts to the ram boxes *B* and secured at their rear ends to a channel structure *B'* extending laterally across the furnace. These box girders support the plates *C*, which form the bottom of the retorts. Resting upon the top of each box girder are the grates *D*. These grates have an expansion joint between two sliding surfaces and the expansion space is further packed with asbestos at *E*.

Bolted to the ends of the box girders are the brackets *F*, which form a support and air-supplying channels for the moving-grate sections *G*, and the dumping grate *H*.

The moving-grate sections reciprocate with a variable stroke between certain limits. The dumping grate is pivotally mounted on the brackets *F*. Between the bridge-wall and the end of the dumping grate *H* are secondary corrugated dumping-grate sections mounted on a shaft. The upper surfaces of the moving- and the dumping-grate sections consist of interchangeable corrugated grate bars *I*.

At the upper end of the box girders and extending laterally across the furnace are air-distributing boxes *J*, having a double row of nozzles for injecting air above the fuel bed. These boxes are bolted to the ram boxes *B*. The air-distributing boxes also form an expanding throat section for the coal fed into the furnace.

The fuel-feeding mechanism for each retort consists of a cylindrical plunger or ram *K*, having an inclined face *L*. The ram is connected by a rod *M* to a steel crank-

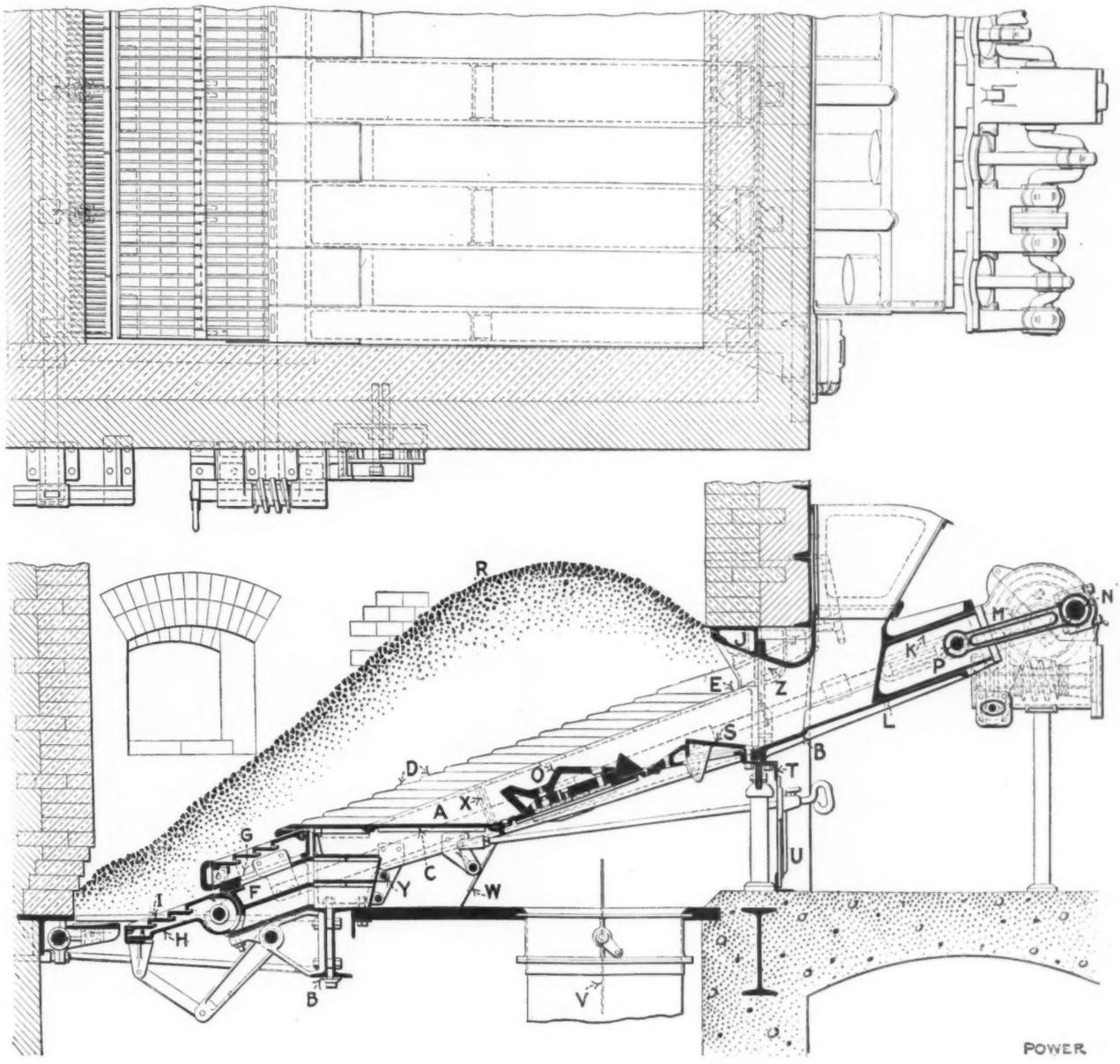


FIG. 1. DETAILS OF THE NEW WESTINGHOUSE UNDERFEED STOKER

shaft *N*. The crankshaft is rotated through a double set of worms and gears driven from the speed shaft and sprocket, which, in turn, is connected by a chain to the main driving shaft.

The secondary pusher *O* is actuated through connecting-rods from the pin *P* and the stroke of the pusher is adjustable.

The moving-grate sections *G* are also connected to the pin *P* through suitable rods and reciprocate with an adjustable stroke in unison with the main plunger. The different crankshafts are set 90 deg. apart, thus distributing the load on the worm gears.

The stroke of the main ram is 12 in.; that of the secondary ram is generally three inches and may be varied from five to one inches, depending upon the condition of the fuel bed and the fuel used. The stroke of the movable-grate sections will vary from nothing to a maximum of three inches.

The dumping grate *H* is operated by a worm gear and shaft and levers through a ratchet at the side of the furnace. The bridgewall dumping grate is operated from the side of the furnace by a lever, and can be so adjusted that the ash is moved forward by the grate *G* and is continuously discharged. The position of the main dumping grate may also be adjusted to accomplish the same result.

The coal from the hopper is forced over the grates into a position indicated by the outline *R*, being deepest at the front portion of the fuel bed and gradually declining toward the rear. The fuel bed with varying fuel is maintained through the use of the relatively small incline of the stoker and the adjustable deflecting plate *S*.

The space under the grates is sealed by means of a reinforced-concrete floor and the front plate *T*, which carries the air-tight doors *U*, used for inspection and to admit air when the stoker is operating under natural draft. Under forced draft, the air is admitted through the main damper *V* and is further distributed in correct volume and pressure to the fuel bed through the damper *W*, which controls the air for the lower portion of the grates. A partition *X* in the box girder segregates the grates into two parts.

Air for the moving-grate sections is controlled by the damper *Y* from the side of the furnace. The air for the distributing box *J* passes through the connections *Z* and is controlled by dampers operated from a single shaft.

The absence of moving levers and links under the front of the stoker permits installation where there is restricted head room and where boilers are set relatively low and still maintain a large combustion space. The ash hoppers can also be separated from the boiler room as no levers or operating rods pass through them. This arrangement prevents ashes or gases from coming into the boiler room.

The fuel bed *R* is almost twice as thick at the front as it is at the rear of the furnace, and, therefore, the resistance to the passage of air is greatest at the front. Most of the volatile gases or hydrocarbons are distilled and pass through the fuel bed at the front, and as these hydrocarbons require almost three times as much air for combustion as does the coke, the importance of a large air supply at this point is apparent.

In this stoker the volume of air at the highest pressure employed for a certain rating enters under the front part of the stokers. The proper volume of air at a lower pressure is admitted to the lower end of the fuel bed through the dampers and is gradually decreased as it passes through the dampers for the moving and the dumping grates to suit the gradually decreasing thickness and combustible percentage of the fuel bed. The secondary air is diffused with a carbon monoxide gas above the fuel bed through jets arranged across the width of the furnace, and the air and gas are well mixed.

By this arrangement of introducing the correct amount of air at the necessary pressure and in the proper part of the fuel bed, less air is required per pound of coal, thereby increasing the furnace temperature and decreasing the stack losses due to excess air.

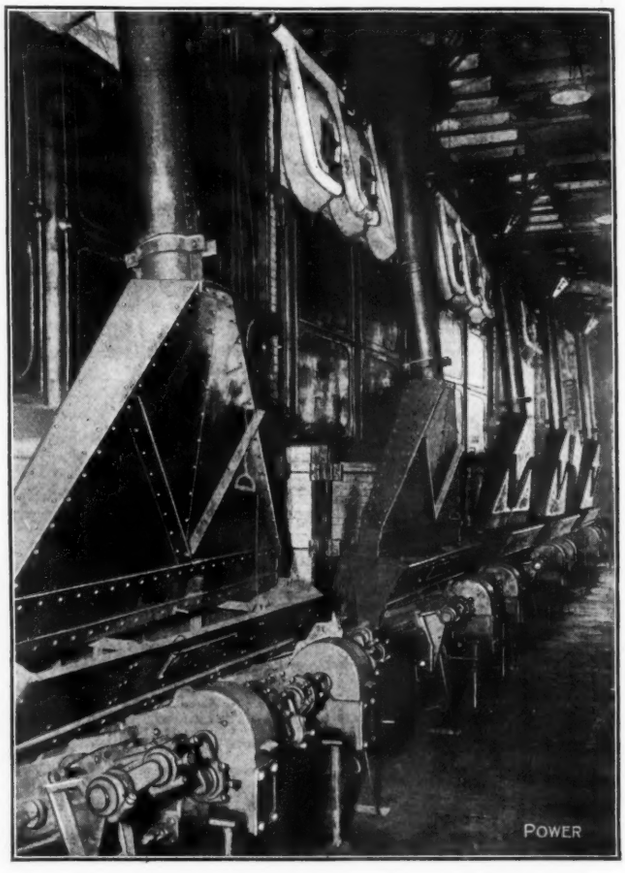


FIG. 2. WESTINGHOUSE UNDERFEED STOKERS

The novel combination of an active grate under forced draft, which at the same time serves the purpose of a dumping grate, allows the installation of a maximum active grate area for high capacities inside of certain given furnace dimensions.

Through this control of four different parts of grate surface, the best rate of combustion per square foot of grate surface for a certain boiler rating can be maintained by operating the different dampers. For instance, at low ratings under forced draft the air may be closed off from the moving and the dumping grates. While these grates then serve only as a collecting surface, they may, with the demand for increased boiler capacity, be added as active grate surfaces. Thus the efficiency curve of the grate will be almost a straight horizontal line for boiler capacity varying between wide limits if plotted against the percentage of efficiency on a vertical line.

The stoker, attached to a battery of boilers, is shown in Fig. 2.

Equipment and Methods in Largest Refrigeration System--II

By Charles H. Bromley

SYNOPSIS—Interesting features of the largest refrigeration unit ever constructed. The machine is built for the unusually high speed of 75 r.p.m. and handles two widely different suction pressures. The builders were required to work to measurements in thousandths of an inch. Very fine pitch threads on the piston rods prevent them from backing out of the crossheads. The center crankpin is grooved circumferentially midway between the cranks so that, should it break, the machine will run as two side-crank engines. Hydraulic jacks are permanently located under both flywheels for raising the shaft.

Features of the 1000-Ton Compressor

One thousand tons of refrigeration every twenty-four hours! And from one machine, in the Sargent's Wharf plant of the Quincy Market Cold Storage & Warehouse Co., Boston, Mass.

One ton of refrigeration capacity is the ability to absorb as much heat as will melt one ton of ice at 32 deg. F. into water at 32 deg. F.; the latent heat of ice at 32 deg. F. is 144 B.t.u. Then, with no losses, to freeze 1000 tons of water at 32 deg. into ice at 32 deg. F. requires

$$1000 \times 2000 \times 144 = 288{,}000{,}000 \text{ } B.t.u.$$

Suppose that the 25-lb. cake of ice your iceman puts into your refrigerator keeps it sufficiently cool for two days. One day's capacity of this machine would keep it cool for

$$\frac{288{,}000{,}000}{\frac{144 \times 25}{2}} = 160{,}000 \text{ } days$$

440 years continuously; or, if it were cooling ice boxes of this size, one day's capacity would keep 80,000 such boxes cool for two days. And one day's capacity is equal to the heat absorbed by the melting of a pillar of ice one foot square in section and 34,662 ft. high. This is nearly 46 times as high as the Woolworth Building, over 5600 ft. higher than Mt. Deodhunga in the Himalayas, believed to be the highest in the world; and, if the pillar could be pushed vertically to the greatest ocean depth discovered (31,614 ft. in the Pacific), it would rise above the surface 3048 ft.

The compressor weighs about 1,000,000 lb. and there is approximately 15 tons of bronze in the bearings. Thirty-five cars were required for its shipment. The foundation weighs about 2,500,000 lb. and contains over 800 yd. of concrete anchored to a mat which rests upon steel caissons driven into the blue clay and filled with concrete.

Judging from the performances of the other machines—the 800- and the 400-ton—Mr. Fairbanks, chief engineer for the company and designer of the compressor, feels confident that he can produce refrigeration with the 1000-ton machine for 20 cents per ton, which includes pumping the brine. With the 800-ton compressor the cost is 25 cents per ton. These costs do not, of course, include the overhead charges.

The 800- and 400-ton machines were heavily overloaded and the continually increasing demands called for an unusually large machine to relieve the overloaded ones and serve for future growth. Nearly all the land the company owned was already occupied, so a 1000-ton machine was decided on to occupy the engine-room space available after moving a large brine pump. Many of the compressor builders were consulted, but none cared to construct the machine according to the specifications, which required its making a speed of 75 r.p.m. This speed is much higher than large compressors are run; 40 r.p.m. is considered high and is usually utilized for short periods only. Ammonia-compressor speed is dependent primarily on the rapidity with which the ammonia valves will open and close successfully; therefore, the design of these valves, to be taken up later, is interesting.

When the specifications were drawn and all the drawings were completed, the Farrel Foundry & Machine Co. of Ansonia, Conn., started making the large castings and the Providence Engineering Works did all the machine work. The builders were required to work to measurements in thousandths of an inch. Wherever possible, a reasonable leeway, above or under or both, was permitted. Although at first the workmen were annoyed by being held down to such narrow limits, they later expressed their approval of the practice and the designer heartily commends the builders for so successfully meeting the specifications. Although the machine was not erected before being assembled on its present foundation, every part fitted without alteration.

While the plant's drafting force consists of three draftsmen, several additional men were obtained from the builders to assist in drawing the plans, a charge of 70 cents per hour per man being made. Skeleton patterns were used and, as they were ready to be drawn from the molds, the designer was notified and visited the Farrel Foundry & Machine Co. to inspect the mold before the pouring was done. This was a wise precaution, because if slight changes in the mold were desired the designer could instruct the molder to allow for slightly more or less thickness here or there. The molder could do most of this finishing with a trowel. The use of skeleton patterns was a big saving, for if the usual type patterns had been used they would have cost about $3500 more.

All yokes are of openhearth cast steel instead of cast iron as is usual. Ordinarily, crankpins are made of comparatively low-carbon steel and are case-hardened, but the crankpins of this machine are of 0.45 carbon steel, annealed.

Experience with both of the other machines—they had bedplates of usual weight and strength for all stresses—proved that they were insufficiently reinforced transversely to be absolutely safe against fracture under all normal conditions of stress imposed by the continuous service. The bedplate of the 400-ton compressor, for ex-

ample, broke three times in the same place, namely, in the middle between the A-frames and immediately under the shaft housing. Now all bedplates, including that of the 1000-ton machine, are reinforced about three times as much as in common practice, for a fractured bedplate is serious and long shutdowns here are out of the question. It was near the end of a busy season when the bedplate of the 400-ton machine last let go. Only the two machines were available then, for the 1000-ton compressor had not then been built. It was dangerous to run this already overloaded machine in this condition, but the exigencies of the service demanded that it be done for weeks or until the load dropped.

These were not the only fractures in this plant, and experience here and in other places leads one to conclude, notwithstanding all that has been said and done about it, that designers would do well to continue giving more consideration to the effects of fatigue in parts of machines in nearly constant service or likely to experience such service, and make greater allowances for it.

Fine-Pitch Threads for Piston Rods and Other Parts

United States standard screws have eight threads to the inch for a 1-in. diameter screw, 4½ for a 2-in.; 3½ for a 3-in.; 3 for a 4-in.; 2½ for a 5-in.; and 2¼ for a 6-in. Engine builders, however, usually use threads of a little finer pitch for such parts as piston rods, plunger rods, etc.

Here again experience showed the necessity of going common practice one better if accidents and shutdowns due to piston rods backing out of the crossheads were to be made remotely possible. The threads must be of a much finer pitch so that after a nut was set up and driven home with a hammer blow on the wrench, it would stay tight. The piston rods of the new compressor were given threads of finer than usual pitch—the 6½-in. rod having 6-in. threads to the inch—and, as the rods in the other machines are renewed they too will be so threaded.

As an additional safeguard against rods backing out, a screw with a large round head is put into the piston rod near the crosshead after the rod has been screwed in as tightly as possible. The engineers and oilers are instructed to watch and feel these screws as they make their regular rounds. If the head of the screw is above or below a horizontal line through the center of the rod, the attendants know that the rod is backing off or screwing in. Soft-steel washers are used under all nuts such as those for the foundation, frame and flywheel bolts. To avoid troubles due to the expansion of foundation bolts of unequal lengths, which sometimes puts serious stresses on parts of the bedplate, Mr. Fairbanks provided for bolts of equal length.

Main Bearing Shells Bored in Position

After the bedplates were erected, the foundation grouted and the cement thoroughly set, the bedplates were pulled into position by 56 foundation bolts, each of 3 in. diameter and 14 ft. long. The jaws carrying the main bearing shells were next bored in position with a bar to insure perfect alignment of the shells. The specifications called for a deviation of not over 0.002 in. Micrometer measurements showed that there was a deviation of only seven-eighths of 0.001 in. All bearings are of specified bronze with diagonal babbitt inserts in the larger ones. The takeups are of the draw-wedge type, with double capscrew lock. There are 15 tons of bronze in these bearings.

Jack under Flywheels to Lift Shaft

Everyone who has had to stop an engine because of a hot main bearing and scrape and fuss with the bearing before the machine could be put back in service, knows that considerable delay is occasioned. To avoid this at the Sargent's Wharf plant the bearing shells are in duplicate and turned within 0.002 in. of each other. Should a hot bearing fail to be cooled by even refrigeration-plant methods, and a shutdown results, the bearing caps may be removed and the shaft and connected parts raised by permanently located hydraulic jacks, one under each of the two flywheels. The hot brasses may then be lifted out and cool ones inserted.

These jacks are, of course, a convenience and undoubtedly save time, but on account of the size of the machine it would take about four hours to remove all caps, replace the hot with cool shells and get the machine back into service. Here is where the deflection of the main shaft proves valuable.

Deflection of the Main Shaft

This shaft is 24 in. in diameter by 26 ft. long, has a 7-in. hole through the center and is of 0.45 carbon, fluid-compressed, openhearth steel with a tensile strength of 90,000 lb. per sq.in. While measuring the deflection of the shaft with disk micrometers, a valuable discovery was made. (Bear in mind that it would require about four hours to put new brasses in a bearing.) While measuring the deflection between No. 3 bearing and No. 4, or the outboard bearing (the jack or load on the shaft being applied at No. 4), it was found that the micrometer at No. 4 showed a deflection of 0.019 in. before the instrument at No. 2 began to show any deflection, but 0.011 in. deflection liberated the bearing shells. So, if ever it becomes necessary to quickly put new brasses in either of the outboard bearings, the cap of the affected bearing only need be lifted and the shaft raised with a jack until the brasses are free to be pulled out. Although there is considerable deflection between two bearings, it might be found that when the brasses were hot they could not be relieved by the jack until the cap on the next bearing was loosened a trifle, but this would occasion no appreciable delay.

Machine Two Side-Crank Engines if Center Crankpin Breaks

The cranks are of 0.35 carbon openhearth cast steel and the connecting-rods of 0.45 carbon openhearth forged steel; the crankpins also are 0.45 carbon steel annealed. The center crankpin (the compressor has three vertical ammonia cylinders and two horizontal steam cylinders) has a groove ⅛ in. wide by ¼ in. deep in the circumference of the pin midway between the cranks. In case of serious stress from any abnormal condition, the pin would presumably break in the groove, thus leaving the two sections of the pin in their respective cranks, and allowing the compressor to be run as two side-crank engines.

The next and third article of the series deals with many other points of interest about the 1000-ton compressor.

Will Quizz, Jr.

SYNOPSIS—Chief Teller, following the discussion of the barometer, gives Will a line on the manometer.

"The other day, Will, we discussed the barometer. There is another meter which is equally interesting, called the manometer, or, more familiarly, a pressure gage."

"Gee, Chief, a manometer must be a gage with a college education to have a name like that."

"After all, son, in its simplest form it is just a U-tube with any liquid inside—usually water for low pressures and mercury for higher. With the U-tube partly filled, any pressure exerted on one side will depress the liquid in that side and drive it up in the other. Don't you remember? We used it in the discussion of heating piping some time ago" (p. 51, July 14).

"You are familiar with draft and blower gages having water in them, so we will pass to the mercury tube and see what may be learned from it.

"To begin with, if we put mercury into a rather long U-tube and connect one side to a boiler or other source of pressure, the mercury will be depressed in one side and driven up in the other. You will remember that a column of mercury 30 in. high, at the level of the sea and under ordinary atmospheric conditions, will exert a pressure of 14.7 lb. Therefore, the difference in the level of the mercury in the two sides of the U-tube indicates the pressure being exerted on the one side more than on the other. This difference in the level in inches, Fig. 1, multiplied by 0.49001 or mulitplied by 14.7 and divided by 30, is resolved into pounds pressure. Or, as our foreign friends often express it, each 30 in. equals so many atmospheres, plus one, for there is always one atmosphere acting on the open side. This furnishes an accurate method of testing steam gages and indicator springs, but, in this case again, we must consult the barometer.

"Another form of manometer has the tube closed at the top and as the mercury rises in that side it compresses the air in the tube. Therefore, it does not require such a high column of mercury. The air trapped in the tube follows a definite law, known as Boyle's or Mariotte's law, which is expressed by the $P \times V = C$ formula. Get this formula fixed in your mind, Will; I got started on this subject for that purpose. This law enters into the study of the action of steam in an engine cylinder or of air in a compressor—in fact, it is one of the laws most frequently met with in the study of gases under pressure."

"What does this law mean, Chief, and how was it established."

"In 1662, Robert Boyle, an English physicist, and, independently, in 1679, Edme Mariotte in France made experiments and came to the same conclusions; namely, 'The temperature remaining the same, the volume of a given quantity of gas is inversely as the pressure it bears.' There are slight variations at extreme pressures and with different gases, but for practical purposes they need not be considered.

"The law is known in England as Boyle's Law and on the Continent as Mariotte's Law; in this country by either or both names.

"It means that when a given volume of gas is compressed into a space of one-half the volume and the temperature is kept the same as before, it will have double the pressure it had at first, or, if allowed to occupy double the space, it will have only one-half the original pressure. The temperature remains the same, remember. If, one at a time, such facts can be made to stick like a burr, it won't be lost nor will the time be ill spent."

"But, Chief, do not air and all other gases get more heat when compressed?"

"The heat of compression you refer to is not that the gas gets more heat than it had, but that the total heat, of a cubic foot for example, is compressed into a much smaller space. That is a subject we will talk about some other time, not to get off this present one. In this experiment the heat incidental to compression must be removed and the temperature brought to the same degree. The illustration will give you the story. (Fig. 2.)

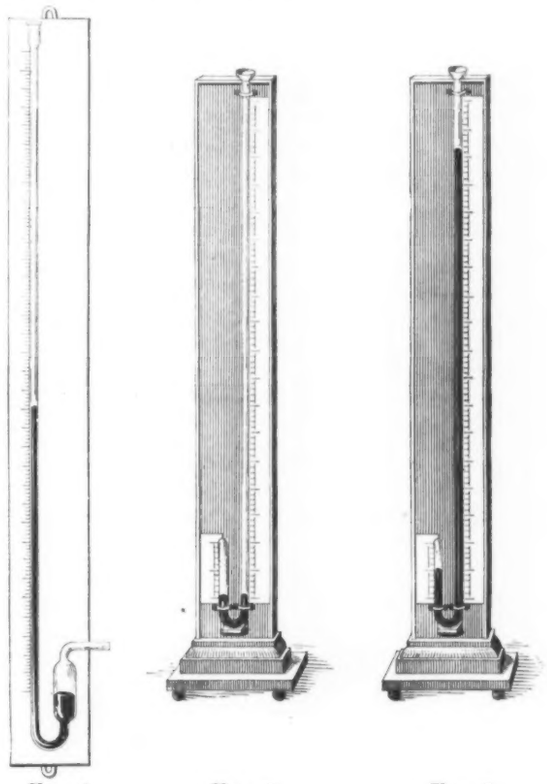


FIG. 1. FIG. 2. FIG. 3.

MERCURY MANOMETERS

"The short end of the tube is closed and the other is open. With just enough mercury poured in to fill the tube at the bend, it is evident that the air in the short side will be at the same pressure as the other—14.7 lb., or one atmosphere—and the mercury will be at the same level in both. If, however, more mercury is poured into the long tube it cannot rise in the short tube except as it compresses the air somewhat. If we continue to pour in mercury until there is a difference of 30 in. between the heights of the mercury in the two sides, it will be found that the mercury in the short tube has risen halfway between the first mark and the top of the short tube. Therefore, as the air in the short tube is sus-

taining an unbalanced column of mercury 30 in. high, it has a pressure of 14.7 lb. above the atmosphere, or two atmospheres in all, and it occupies a space just one-half as great as originally." (Fig. 3.)

"Will the space the air occupies be reduced one-half again if 30 in. more of mercury is poured in?"

"No, Will, whatever pressure there may be on the air must be doubled in order to compress the air into one-half the space. Therefore, to get it compressed into one-half the space and have the pressure consequently doubled, it is necessary to put in twice the height of mercury next time—that is, 60 in. more, making 90 in all, above the level in the short tube (not above the original level).

"You see, the air will occupy a fourth of the original space and have four times the pressure, or four atmospheres, three of which will be due to the 90-in. head of mercury and the fourth to the air pressure on top of it in the long open tube. So, this is the $P \times V = C$ formula, which is the short statement of this law, where P = pressure, V = volume and C is the constant quotient when the two variables are multiplied together. The same law applies to the expansion of gas, so if the space or volume be increased the pressure will be reduced as a result. For an every-day example, take the expansion of steam in the engine cylinder after cutoff and in the other way to the air in the compressor cylinder. At some future time we will take up the application of this law to our own plant."

Why the Isolated Plant Should Win

By Henry D. Jackson

SYNOPSIS—An analysis of central-station costs, showing that while the actual switchboard cost is low, the overhead charges, losses and distribution expense bring the total cost far above that in the isolated plant, providing the latter is operated efficiently.

At a gathering of engineers recently, one said that the time was coming when every large city would have but one central plant for heat and power. He based his argument on the value of concentration as regards the cost of generation and distribution of power.

That such is the trend so long as the central stations are controlled as at present, cannot be denied; but that such is not the logical trend if such plants are regulated for the benefit of the people at large and not for the few, the writer believes, cannot be denied.

The large central plants can and do produce power at the switchboard at prices below that attainable by most of the isolated plants under the present system of construction and operation. This is due to a number of things among which are:

1. The generating units are large and designed for the most efficient operation.
2. Careful operating methods are employed.
3. There is every refinement in the plant to gain low operating cost.
4. The boiler room is carefully watched and every step is taken to secure the utmost results from the coal.

All of these result in very low operating costs and, therefore, in a low cost of power at the switchboard; but many of them add largely to the fixed charges, which must not be lost sight of.

Few of these refinements are worth while in an isolated plant. The size of the unit is dependent on the power required and, to a certain extent, the economy of operation may have to be sacrificed somewhat. This depends largely on the conditions, which often call for a comparatively inefficient unit, so far as steam consumption is concerned, owing to the value of the exhaust steam for other purposes. Therefore, it is often advisable to purchase a moderate-priced unit, inefficient in steam, but efficient as concerns the whole plant, owing to the reduction in fixed charges.

As for operating methods, there is no reason why a small plant should not be as carefully operated as a large one. Refinements of this nature can be made in an isolated plant just as well, providing they are warranted by the resultant gain. It is in the boiler room where most of the isolated plants fall down and where the greatest gain can be made by proper supervision. The cost of coal is about one-half the total cost of power at the switchboard, even in the large plants, and this may reach a large proportion of the total costs in other plants.

The coal that is wasted in the majority of isolated plants is astonishing. It is not uncommon to find plants using high-grade coal, ranging from 13,500 to 14,000 B.t.u., with an evaporation in the neighborhood of six pounds, even with hot feed water. This unquestionably results from improper firing, a poor condition of the boilers, and possibly such causes as poor boiler settings. By far the greater cause is that no steps are taken to measure the water fed or to weigh the coal; hence, neither the fireman, engineer, nor owner has any idea from day to day as to what the boilers are doing. The only thing the owner knows is that his coal bills are steadily going up, although the plant output may be holding constant. Arguments by the engineer or fireman for the installation of scales and meters are frequently of no avail. These cost money, and the owner either cannot or will not see that money spent here will return larger dividends than that spent in almost any other part of the plant.

Central stations, on the other hand, in order to obtain low production costs; install meters and scales wherever they will show valuable results, and recording or indicating devices to show the condition of the furnaces and what the boilers are doing; until at present the fireman has at his service far more devices to show what is going on than the engineer. This is economy.

Unless the boilers are kept clean, there will be an increase in the coal necessary to evaporate the water; unless the coal is properly fired, much will be wasted; unless the dampers are properly regulated, a large part of the heat will go up the stack or much of the coal will not be completely burned; and unless the feed water is properly regulated, the steam pressure will fluctuate. Therefore, it will be seen that the fireman, who is poorly paid as compared to the engineer, is responsible for far more value than is the latter for he can in many cases waste more

than his wages every day without its being apparent, unless adequate records are kept.

In most plants, it may not be necessary to install all, or even a small part, of the boiler-room devices available; but meters to measure the water, scales to weigh the coal, thermometers to determine the temperature of the feed water, and feed-water purifiers, in case the water is bad, are essential features for economical results. In addition, CO_2 recorders and steam-flow meters are valuable adjuncts and will help to keep down the costs. Every big plant has these devices, and every day more of them are being used in the smaller plants.

Consider, for instance, a 500-hp. plant utilizing 15,000 lb. of steam per hour in a 10-hr. day, with an evaporation of 10 lb. This would represent 15,000 lb. or 7½ short tons of coal per day. At an evaporation of 5 lb., it will represent 15 tons per day. With the coal costing $4 a ton, an evaporation of 10 lb. would represent $30 per day against $60 with an evaporation of 5 lb. This is an extreme case, to be sure, but it illustrates to a marked extent what is often done as compared to what might be attained. The difference of $30 in one day will go a long way toward paying the interest on the devices necessary for measuring the water in an isolated plant of 500 hp. and every other day will pay a large dividend on the investment, part of which could well be spent as a bonus to the fireman for keeping up the good work.

One might be led to ask: What has this to do with the central stations? It has this to do with them. Central stations, as a rule, could not compete with isolated plants if the plant owners would attempt to operate their plants as the central stations are run. If the plant owners would put the same amount of energy and care into operating their plants that they put into the operation of other departments of their factories, there need be no fear of central-station competition.

Attention has been called to the cost of coal as approximately one-half that of power at the central-station switchboard, and for this reason the managements have put an enormous amount of energy and money into reducing their coal bills. It might be equally instructive if attention were called to the fact that the cost of power at the central-station switchboard is but a small item in the total cost of power as delivered to the customer, for the central station, owing to its high investment, has exceedingly heavy fixed charges.

It is a common belief that in central stations the investment per kilowatt of capacity is low, owing to the large units. Many large central stations carry their plant values on their books, exclusive of real estate, at approximately $110 per kilowatt. This is far higher than would be the cost of a moderate-sized isolated plant, including the real estate and building, which can be installed for about $100 per kilowatt, with every refinement necessary or desirable for the most efficient operation. Thus, the fixed charges on the central station should be as heavy and, in fact, heavier than those of the isolated plant per kilowatt of installation; and as the central-station units run but a comparatively short time at full load, the actual fixed charges per kilowatt-hour are far greater than in the case of the average isolated plant. This covers only the power plant. In the isolated plant, the fixed charges cease here. In the case of the central station, however, there must be added the fixed charges on office buildings, transmission lines, transformers for distributing, meters for recording, and other incidental apparatus required for carrying on the business. Thus, the fixed charges become a large item in the cost of power as delivered.

The power when it reaches the isolated-plant switchboard has reached the end of its cost, for, in comparing its cost with that of purchased power, it is at this point that the central-station power charge begins. In the case of the central station, however, when the power has reached the switchboard, its cost has but just begun. This power must be distributed, and many times it has to be carried miles before it reaches the customer. There is a heavy loss over these lines, also in the transformers and meters, and the plant itself uses a large amount of power for advertising and other purposes; so that the power actually delivered to the customers ranges from 70 to 75 per cent. of the power generated at the station. Thus, the power cost at the station must be increased by the time it arrives at the consumers' premises by 25 to 30 per cent., in order that it may cover the actual cost to the central station. This is for line or transmission losses alone.

The transmission lines must be added to from time to time, and replaced and maintained, which is expensive. The general handling of the business details of the central station is also expensive, for the meters must be read, their readings returned to the office, checked, the cost made out and bills rendered and collected; the plant or plants must be supervised, the officers' salaries must be paid, and all the details of a large office and engineering organization have to be accounted. Moreover, a central station must pay taxes, as any other business. In addition, there are a number of incidentals not enumerated, together with interest on the investment, covering the plant, real estate, lines and all the apparatus necessary for the carrying on of a central-station business. These items, based on a kilowatt of output, are invariably several times the actual switchboard cost. On an average, the cost at the switchboard will be about one-sixth that as actually delivered to the customer. This being the case, it is hard to see wherein a central station can compete with an isolated plant if the isolated plant is operated with the same attention to detail as is the central plant.

The British Thermal Unit—One B.t.u. is the quantity of heat required to raise the temperature of one pound of water one degree. As a gallon of water weighs 8⅓ lb., it requires 8⅓ B.t.u. to raise the temperature of one gallon one degree, or 16⅔ B.t.u. to raise the temperature two degrees, and so on.

Thus, when a given coal is said to have a heat value of 13,800 B.t.u. per lb., it is meant that if all the heat caused by the complete combustion of one pound of that coal could be transmitted to 13,800 lb. of water it would raise the temperature of that water one degree. Or, if all the heat could be transmitted to, say 138 lb. of water, it would raise the temperature of that water just 100 deg., because

$$138 \times 100 = 13{,}800$$

The pounds of water heated multiplied by the number of degrees the temperature has been raised equals the number of B.t.u. The standard method of finding the heat value of a fuel is to burn a small sample of it in a tight steel bomb under water. The heat caused by the burning of the sample is then all absorbed by the water and by multiplying the weight of the water by its rise in temperature and dividing by the weight of the sample, the heat value of the coal is calculated direct in B.t.u. per pound. Thus, if we burned a small sample weighing one-five-hundredth of a pound in a bomb immersed in 5 lb. of water, and if the temperature of that water increased from, say, 70.4 deg. to 75.92 deg., a rise of 5.52 deg., the heat value of the coal would be

$$\frac{5 \times 5.52}{0.002} = 13{,}800 \text{ B.t.u. per lb.}$$

The Nicholson Furnace

Consisting of a set of hollow grate bars, a forced-draft outfit and galvanized-iron ducts connecting the fan with the ashpit, the Nicholson furnace has been recently placed on the market to increase the capacity and efficiency of a boiler over results obtained with natural draft and hand-firing. It is especially adapted to burn slack and cheap grades of coal efficiently, due to the thorough mixing of the air with the products of combustion.

FIG. 1. NICHOLSON GRATE BARS

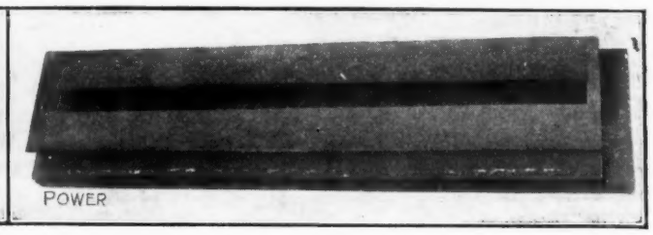


FIG. 2. BOTTOM OF BAR

The grates are hollow cast-iron bars of the general shape indicated in Figs. 1 and 2 and are made in sizes to fit the furnace. The depth of the bar is about 6 in., the width varies from 8 to 9 in. and the length is decided by the furnace. As no change in setting is necessary, the grate may be easily adapted to old boiler plants. As shown in Fig. 3, the grates are placed side by side on the rest bars of the former furnace or on the bars of a new installation. A mixture of fireclay and cement is filled in between the bars and around the sides so that no air can enter the furnace except through the circular and

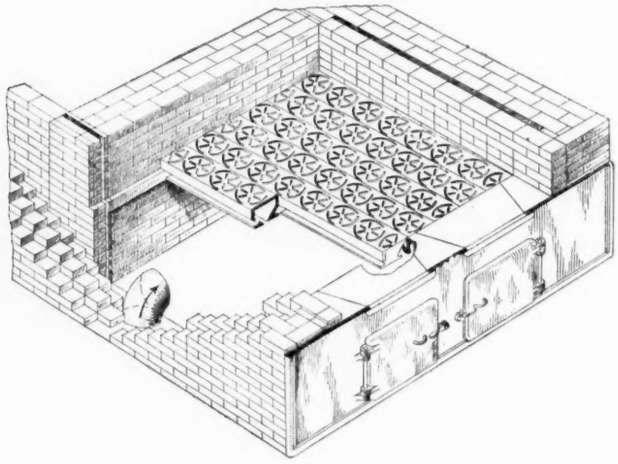


FIG. 3. BARS PLACED IN FURNACE

radial slots shown. These slots are all cut at an angle so that the air is thoroughly diffused and forced to every part of the fuel bed. The jets of air meet and mix with the fuel gases instead of passing directly upward through the fuel bed. The air space forms only 8 to 10 per cent. of the grate surface, but an air pressure of ¾ to 1 in. of water in a sealed ashpit insures the passage of sufficient air through the slots to burn the coal. Due to the design of the bottom of the bar and the restricted openings, an equal distribution of air over the whole grate surface is insured.

As the slots are at an angle, and narrow at the top, it is difficult for small particles of coal to fall through against the air pressure, and as the openings are larger at the bottom there is little tendency to clog. The proportions of the bar and the hollow construction present a large cooling surface to the air, which tends to keep the grates cool and prevents clinkering.

The fan is located centrally with a flue to each ashpit. The speed of the fan may be controlled by the throttle, or automatically, and a damper in each flue permits individual adjustment.

On tests made on a horizontal tubular boiler and Nicholson furnace at the Rock Island water-works, the results given in the accompanying table were obtained with inferior grades of coal. The maker of the furnace is the Improved Combustion Co., 445 Peoples Gas Building, Chicago, Ill.

DATA AND RESULTS OF EVAPORATIVE TESTS

	Kind of Fuel (1) Franklin Co. 2-In. Screenings		Kind of Fuel (2) Matherville (Mercer Co.) 2-In. Screenings	
Duration of trial, hr.	10		10	
Grate surface, sq.ft.	58		58	
Water heating surface, sq.ft.	2980		2980	
Av. corrected steam pressure, lb.	109.4		109.6	
Av. temp. of external air, deg. F.	3.5		16.2	
Av. temp. of fireroom	59		60	
Av. temp. of feed water, deg. F.	150.8		148.6	
Prox. analysis of coal—	Dry Coal	Combustible	Dry Coal	Combustible
Fixed carbon, per cent.	52.8	60.9	37.1	50.3
Volatile matter, per cent.	34.05	38.1	36.9	49.8
Total moisture, per cent.	9.0		12.5	
Ash "dry coal," per cent.	13.15		25.0	
Sulphur "as received," per cent.	1.9		6.0	
Dry coal per sq.ft. grate surface per hr., lb.	10.58		12.9	
Calorific value by Parr calorimeter "dry coal," B.t.u.	12,247		10,216	
Horsepower developed	162		172	
Builders' rated horsepower	300		300	
Water evap. per lb. of coal under actual conditions, lb.	7.5		6.26	
Equiv. evap. f. and a. 212 deg. F. per lb. of wet coal, lb.	8.3		6.95	
Equiv. evap. f. and a. 212 deg. F. per lb. of dry coal, lb.	9.13		7.95	
Equiv. evap. f. and a. 212 deg. F. per lb. of combustible, lb.	10.5		10.60	
Efficiency of boiler, per cent.	72.0		75.0	
Cost of coal per ton delivered	$1.975		$1.40	
Cost of fuel used for evap. 1000 lb. of water f. and a. 212 deg. F.	$0.1186		$0.1008	

Nitrogen Lamps Under Varying Voltage—An experiment was performed recently with a 400-watt gas-filled nitrogen lamp rated at 110 volts, for the purpose of finding the behavior of the filament when subjected to low voltages. The results were as follows: Barely red at 9 volts; bright red at 20; very red at 30; white at 40; dazzling white at 50, and blinding white at 110. It would appear from this that the fluctuations in voltage will be less apparent with the nitrogen lamp than with the old style lamps.

The Efficiency of the Electric Generator is the ratio of the useful output to the total input, or letting

E = Total energy used in driving the generator;
E′ = Energy available at terminals of the machine;
e = Total losses.

$$\text{efficiency} = \frac{E'}{E} = \frac{E'}{E' + e} = \frac{E - e}{E}$$

The efficiency of ordinary alternators varies from 90 to 95 per cent. The losses consist of windage, bearing and brush friction, iron losses and copper losses.

Editorials

New York City's Refrigerant Regulations

On January first the regulations of the Fire Prevention Bureau of the Fire Department of New York City governing the use and handling of refrigerants go into effect. These regulations are printed on page 862 of this issue.

Engineers, manufacturers—all seem to have learned only recently that the real solution to the boiler inspection, specification and operating problem was a national code such as was formulated and approved at the recent annual meeting of the American Society of Mechanical Engineers. The rules that should govern the local use of refrigerants may with equal benefits be approved by users nationally.

Escaping ammonia gas is just as dangerous in Milwaukee as in Boston, New York or Richmond. Yet New York and Boston, each conscious of the necessity of regulating the disposition of refrigerants, simultaneously started out to investigate and to formulate and apply such regulations. Did they coöperate? No; that would be too unusual. We doubt if either city realized that each had ammonia machines in its confines.

What is the result? On January first New York City will put into effect a set of regulations some of the sections of which are said to be objectionable if not dangerous. This is demonstrated by the Massachusetts Board of Boiler Rules in its investigation of the dangers attendant upon the handling of refrigerants.

For example, section two of the New York regulations calls for a pipe to lead escaped ammonia gas into water or to continue the outlet pipe at least ten feet above adjacent buildings. At the recent annual meeting of the American Society of Refrigerating Engineers, it was pointed out that, although the Massachusetts Board of Boiler Rules, assisted by prominent engineers and professors of engineering, had made investigations into the disposition of escaped ammonia gas, as from compressor heads and condensers through safety valves and piping, these authorities were by no means satisfied with any of the methods in use.

The use of pop safety valves for such service was condemned because they opened too suddenly, quickly liberating too much gas. A valve that would begin to blow at about twenty-five pounds below the pressure at which it was set to open was necessary to give the operator warning timely enough to allow him to take steps to reduce the pressure.

There is need for uniformity of regulations for the handling of refrigerants. Trouble may be expected when the New York City rules are applied.

The American Society of Refrigerating Engineers has not discharged its regulations committee. The American Society of Mechanical Engineers has just been through the experience of drawing up a national boiler code. We suggest that these two bodies, together with the allied interests, confer for the purpose of drawing up a standard set of refrigerant regulations applicable in all cities and agreeable to all concerned.

Congress and the Public Utilities

Congress has recently passed a public utilities law for the District of Columbia which makes it illegal for any public utility to give discriminatory rates. The Public Utilities Commission of the District has begun an investigation of certain rates given by the Potomac Electric Power Co. which are lower than those in the schedule submitted to the commission by the company.

The users affected declare that the contracts, which were drawn in their favor prior to the passage of the public utilities law, were made in good faith and that Congress had no right to enact any law which would cancel these contracts. The commission maintains that it is not a question if Congress had such a right, but if these contracts contain discriminatory rates.

The opinion to be handed down in this case will be of vital importance to those who operate isolated plants or who are contemplating their discontinuance in favor of the special rates offered by the central stations.

A Perpetual Fake

Four years ago we had something to say about a perpetual-motion scheme, which was then being foisted on the public by the National Mechanical Power Co., of 1548 East Sixty Third Street, Chicago. As then explained, the scheme was the old fallacy of falling weights on the periphery of a wheel, the weights being returned to their starting place at a point on the wheel less distant from the center. The same number of weights is ascending and descending at all times and, due to the longer leverage, those going down are supposed to develop excess energy which may be used for power purposes.

In the company's literature the operation was explained as follows: "Each wheel has two rows of pockets, the inner row, called the short side, and the outer row, the long side. The wheel is made to revolve by falling balls. When a ball has passed up the short side to the top, it rolls out into a rectangular conduit, which is fast on the side of the wheel, and rolls down into the outer row of pockets. After it has reached a point near the bottom of the wheel, it passes through another conduit back into the inner row of pockets and is elevated to the starting point, thereby making the *gravity* greater than the *levity*."

Of course, the device is a fake—and an old one. Unless a motor is concealed in the casing, there is small chance of revolving the wheel, and even then centrifugal force may play an embarrassing part. Notwithstanding these minor difficulties, the same promoters, under the firm name of the International Power Co., have bloosomed out suddenly on the west side of the same city. This time, as an extra inducement to buy stock, the company is proposing to build a modern seventeen-story hotel, which will be supplied with power and light by its "fuelless"

engine. Also a couple of models will be on exhibition in the lobby, where they may be seen in daily operation by guests of the hotel and prospective customers for stock.

It appears that the company has had the good sense not to give any visual demonstrations of the working of the machine in its present quarters. Blueprints are in evidence and a photograph of the exterior, but the actual models, it is claimed, are in storage as the company wishes to protect the special constructive features it has adopted. In this way it will have a monopoly when the engine is placed on the market and the dividends to the stockholders will be much greater.

It is not known with what success the company has met in its recent operations. It is our hope that the returns have been small. To the public there is not even the diversion of something new. It is high time for the proper authorities to act.

The Wrong Slant

Much repetition of any statement will make it readily believed. Thus, the alleged wastefulness and inefficiency of the steam boiler and engine have been harped on until now they are popularly accepted as just accusations. We occasionally read, in a Sunday newspaper or equally scientific publication, an article worthy of a recent high-school graduate to the effect that from 80 to 95 per cent. of the fuel in power plants is wasted; in fact, is thrown away. The worst of it is that invariably the implication is that the engineering profession is responsible for allowing this condition to exist.

An engineer employed in the mechanical department of a large factory that maintained an elaborate system of cost-keeping was told by a cost clerk that a considerable saving would result from abolishing the power plant. Of course, the engineer answered that abolishing the power plant would also mean abolishing the factory and the position of cost clerk.

The latter had been discoursing on the economy of the other departments and then referred sarcastically to the power plant's ten per cent. (or so) efficiency in the matter of extracting energy from coal. Explaining that the energy in coal was not all available or possible of utilization, and that the oft-repeated charge of wastefulness was unfair to the power plant, was useless, naturally, for any man that can believe the contrary knows too little about mechanical things to be able to understand.

In the scheme of cost keeping at this plant (in others as well) the power plant was regarded as an "expense"; it did not directly produce any of the finished products of the factory and consequently it was an evil, although a necessary one. This feeling is often evidenced by the attitude of those in the manufacturing departments toward the engineer. It does not occur to the cost department to look at it in the light that the engineer manufactures steam for heating and electricity for power and light, from the raw materials, coal and water; hence is to be classed as a producer. This feeling toward the power department sometimes extends to the manager, who often refuses needed improvements in the power plant on the ground that the "expense" must be kept down.

If the power plants of manufacturing establishments are an expense, they will probably continue so until some clerk or bookkeeper succeeds in making an operative "perpetual-motion" machine.

Engineers in Public Service

It has long been customary to regard municipal engineering as the particular province of the civil engineer; only lately has the important role of the mechanical and electrical engineer in such work become recognized. Significant of the new order of things is the fact that the American Society of Mechanical Engineers devoted an all-day session at its annual meeting to public-service affairs.

That the engineer is already an important factor in municipal affairs, and that this influence will extend, is certain, but it is also evident that under present conditions this field is not as attractive as it might be and the engineer is not accorded full credit for his efforts.

As pointed out by Mr. Cooke, in his excellent paper on "Factors in Municipal Engineering," it is difficult to get the high-class man to enter municipal service, or even to act in an advisory capacity, especially when the point at issue is one between the city and some private company. This may be due in part, as he suggested, to the fact that many of the prominent engineers are affiliated with the private concerns either directly or through retainers, but the "red tape" incident to appointments and the restrictions upon the initiative in such positions are probably equally responsible.

Obviously, the remedy is first to make municipal service attractive, so that the best men will be drawn to it, not merely as a monetary consideration, but as a place where the greatest latitude will be afforded to engineering ability. In this way only, will it be possible to build up a personnel of such a standard as to render municipal undertakings independent of outside aid and at the same time able to meet the private interests on equal terms.

Who Gets the Promotion?

The longer you look at the cartoon this week, the more you realize that it is a real problem that is put up to the boss. The situation is a typical one and the experience a very frequent one with those in managerial positions.

The chap who does not get the promotion can think of many reasons why the boss' choice was a poor one. It is only when one is on the outside looking in, as we are in the case of the picture, purely impartially, that we can begin to appreciate how difficult it may be for a conscientious superior to select the one to promote when all have their good points and each deserves advancement.

Take the three in the picture, consider each one by himself and you will agree that you would hate to be in the position of having to decide which should be advanced.

The point of the picture is this: Do not be too quick to criticize the old man's decisions, for perhaps you may not know what circumstances complicated his problem.

A movement to create a Bureau of Labor Safety in the Department of Labor ought not to scare big business, and elicit squeals from the "Let-us-alone" coterie. Big business ought to be interested in minimizing the death rate in the industrial war. But who objected when unanimous consent was asked for the consideration of such a bill? Smoot!

Correspondence

Detecting Ammonia Leaks

In the Nov. 3 issue, page 656, Robert G. Thurston states that "in testing for leaks in the brine tanks it is best to stop the circulation of brine for a short time and allow the brine to become quite saturated with the ammonia." This is not good practice for this reason: In a brine tank of average size a few pounds of ammonia would be lost into the brine before its presence could be detected by litmus paper or by Nessler's reagent test.

The proper way to test the coils in the brine tanks is to reduce the ammonia pressure in them to about 5 lb. gage; then pump out the brine and test the coils for leakage with a lighted sulphur stick. This is better than to allow the brine to absorb the ammonia until it becomes so saturated that its presence can be detected by litmus paper or by Nessler's reagent.

I have found that smelling the brine is good to discover ammonia leaks, as the brine will give off an ammonia odor long before the litmus paper or Nessler's solution* will indicate its presence.

Further on, Mr. Thurston states that "The greatest sources of ammonia losses are in the compressors, the discharge tanks, the condenser and its valves." I would like Mr. Thurston to explain what he meant when he said "discharge tanks."

The main loss of ammonia in the compressor is caused by leakage past the piston rod through the packing or stuffing-box. This amount should be small in a well regulated plant. Another source of leakage in compressors is the gaskets on the heads, the ammonia so lost being absorbed and carried away by the jacket water. The best and quickest way of detecting such leakage is to operate the compressor without jacket water for a short time, so that the ammonia escapes into the jacket space, and its presence is then readily detected.

One loss in a refrigerating plant, assuming that the system is well looked after and kept reasonably tight, is due to the disintegration or dissociation of ammonia and impurities in the system which cause permanent or non-condensible gases and dead liquor. Deterioration of ammonia is caused by high discharge temperatures and by oil and water in the system. Ammonia gas at high temperatures attacks the iron or steel pipes in the condenser and forms other gases which cannot be liquified at the pressures and temperatures generally carried in the condensers of refrigerating plants.

These permanent gases represent a loss of ammonia, they are a detriment to the economical operation of the plant and they must be removed as soon as possible. Pumping these gases through the refrigerating system causes loss in output and in efficiency. They can be removed by burning them when flowing from the purge valve on the condenser or they may be purged off into a bucket of water. When adopting the latter method it is customary to connect a small pipe to the purge valve and run this pipe into a bucket full of water, submerging the outlet of the pipe several inches below the surface. Then crack the purge valve slightly, and so long as bubbles rise to the surface keep the valve open, but when the bubbles cease to rise and a cracking noise is heard, one may be sure that ammonia gas is escaping from the condenser. Water absorbs ammonia gas with a distinct cracking sound similar to the noise heard when heating cold water with live steam.

The oil and the water in the system will absorb ammonia until they are saturated. The presence of oil is caused by faulty operation, by defective apparatus and by using oil that is not suitable for refrigerating machines.

The main oil trap between the compressors and condensers, which the oil first reaches after leaving the compressors and where it is most readily trapped and drawn off when in the liquid state, should receive the closest attention. It should be equipped with a gage glass and not be allowed to fill to overflowing, so that the oil reaches the condensers, for there it mixes with the ammonia, contaminating it. If the system is not equipped with an ammonia purifier, the oil reaches the expansion coils, and, once there, it is difficult to remove.

Oil for lubricating a compressor cylinder should be free from animal and vegetable fats. These fats are saponified by ammonia, and if they are allowed to enter the system they will soon clog it up. Ordinary mineral oil is also unsuitable, as all such oils contain paraffin, which hardens when chilled. Specially prepared mineral oils should be used, because they have a reasonably high fire test—that is, they remain liquid under high temperatures and will not gasify to any extent (due to the temperature of compression), and thus pass the oil trap as a gas to condense with the ammonia. They have been chilled to zero temperature or lower and the paraffin filtered while solid. An oil so prepared can be used for lubricating ammonia compressors and it will give the least amount of trouble.

Water in the system is, in many respects, more harmful than oil. It gathers in the expansion coils as a mushy frost, and not as a hard lump of ice, as many suppose. In this condition it makes an ideal retainer for any oil that may be in the system.

These two substances, oil and water, in the expansion coils absorb much of the ammonia. The resultant mixture is what is called "dead liquor," which, remaining in the expansion coils, cuts down the efficiency of the coils; also, it reduces the available heat-absorbing surface.

Water enters the system through leaks in the coils or around a leaking compressor cylinder head equipped with a water jacket when any part of the system is pumped down below zero gage pressure for making repairs or for charging in fresh ammonia. It is safer, therefore, to see that the low-pressure gage never registers below zero; in other words, do not pump a vacuum on the system.

When it is necessary to pump down to zero, as in emptying a drum of ammonia, the machine should be

*This may be true for old paper or spoiled solution, but not otherwise.—EDITOR.

slowed down as the back pressure lowers. This should always be done as the needle approaches zero, for with a low back pressure and the machine running fast, a partial vacuum will be formed in the cylinder at the beginning of each stroke. When this happens, it does not take much of a leak around a cylinder head to admit sufficient water to cause trouble.

C. E. ANDERSON.

Chicago, Ill.

Diagrams from New Engines

Replying to Mr. Pearce's letter on page 690, Nov. 10, I wish to state that both diagrams on page 427 of the Sept. 22 issue were from the Corliss type, nonreleasing four-valve engines with shaft governors. It was not a case of more or less lead. The difference was due to that in the design of the valve-gear, and it brings out an important point. I have never found that excessive lead alone or combined with excessive compression would raise the efficiency of any engine, but always to the contrary. Quick opening, to me, always meant increased economy, and this is one example. The diagram showing the slow admission was from an engine with little valve travel. No. 2 had a quick valve movement with a large port opening and had less lead than No. 1; No. 2 showed better average economy as nearly as two distinct types of engines could be compared.

The compression was good in both engines. No. 1 has always shown a higher economy on lighter loads. The boiler pressure and indicator springs were nearly the same on the two engines.

C. R. MCGAHEY.

Baltimore, Md.

Determining Polarity

A simple method for determining the polarity of a circuit, having the added advantage that it does not require any particular preparation, is as follows:

Tear off a piece of blueprint paper (about an inch square will do for 110- and 220-volt circuits) and wet it. Place the two terminals of the circuit about a quarter of an inch apart on a 110-volt circuit and a trifle more on 220 volts. The paper around the negative lead will turn white. A lamp can be placed in series with one of the leads to avoid a short-circuit.

Blueprints are usually available on a job, but I have seen wiremen who had frequent occasion to determine the polarity of circuits, carry strips of blueprints in their tool-kits for this purpose.

P. JUSTUS.

Cleveland, Ohio.

Remedying a Cut Cylinder

M. E. Griffin's method of machining piston rings for gas engines, in the Oct. 27 issue, recalls a job I once saw on a marine-engine cylinder. This was on the intermediate cylinder of a triple-expansion engine, which was about 30 in. in diameter. Upon taking off the head at the end of a trip, the cylinder was found to be badly scored on one side, the cuts running lengthwise about 10 in. and covering a place about 4 in. wide, half-way down the cylinder; the rest of the cylinder was as smooth as glass. The chief was notified and came down to look at it. After looking it over, he put on his overalls and, jumping into the cylinder, called for a hammer and a flat cold-chisel. With these he proceeded to crosscut the whole spot to the same depth as the lengthwise cuts and when he finished, it was a rough looking cylinder. He climbed out with the remark: "I guess that will fix her," and told us to put the head on.

We made a round trip, and upon opening the cylinder again, I was much surprised to find the spot had nearly disappeared. At the end of a second trip the cylinder was found to be smooth all over and one could not tell where the spot had been.

WILLIAM N. WING.

Brooklyn, N. Y.

Simplifying Reports of Boiler Tests

As one of the members of the Power Test Committee, which has just presented its report at the annual meeting of the American Society of Mechanical Engineers, I am interested in the letter of E. R. Morrison in the issue of Nov. 10 on "Simplifying Reports of Boiler Tests."

He will find on p. 55 of this report what the committee considered the best form for a short report, containing only the principal data and results. It has only 21 items, but gives more information of value to the owner and engineer than does Mr. Morrison's form of 39 items. Moreover, this form is in harmony with all the best literature on the subject of boiler tests that has appeared in the past forty years, including the reports of the 1885 and 1899 committees, the Centennial Exhibition reports of 1876, the American Institute report in 1871, and all the reports on boiler tests that have been made in recent years by officers of the United States Navy. If any "busy brainy man" who is "lost among the confusion of unnecessary technical phrases" does not understand this form, all he needs to do is to get his engineer to explain it to him. He would not understand "standard fuel" and "standard evaporation" any more than he would understand "B.t.u." and "from and at 212 deg."

WILLIAM KENT.

Montclair, N. J.

The writer agrees with the views of Mr. Morrison, as expressed on p. 667 of the Nov. 10 issue, that many boiler-test reports could be shortened to advantage and that the chief things which interest the business man are the capacity and economy obtainable. If he is sufficiently interested to pay for obtaining this information, he will probably also wish to know how it compares with the best practice and the reasons, should it fall short.

Mr. Morrison introduces the skill of the fireman as an item, but this is presumably based on the judgment of the engineer conducting the test, and is likely to be a variable factor. It is better to give a complete heat balance as this involves comparatively little extra work and gives exact figures upon which to place the responsibility for the various losses. In fact, the heat balance has been made too much of a mystery in books and it no longer requires an ultimate analysis of the fuel, for if the region from which the latter comes is known, a similar coal can be found in the reports of the United States Bureau of Mines and the ultimate analysis of this can be used in accord-

ance with the method described by Prof. E. E. Sommermeier in his book on "Coal," p. 54.

The writer prefers the following form of heat balance:

1. Heat utilized in evaporation;
2. Loss due to latent heat of water resulting from hydrogen in coal;
3. Loss in products of combustion;
4. Loss due to excess air;
5. Loss due to unburned carbon monoxide;
6. Loss due to unburned carbon in ashpit;
7. Loss due to radiation and that unaccounted for, etc.

The methods of calculating these are fully given by Prof. Sommermeier and need not be repeated here, but the writer has found an even simpler method which gives on tests with coals from the Eastern fields, results accurate to 0.1 per cent. on the heat balance. This is based on the fact that while the heat values of carbon and hydrogen per pound of each are widely different, the heat developed per pound or per cubic foot of oxygen or air used to burn them is not very different. Hydrogen develops 62,500 B.t.u. per lb., and requires 8 lb. of oxygen for combustion, while carbon develops 14,650 B.t.u. per lb. and requires only 2⅔ lb. of oxygen. This, taken with the rather small and uniform percentage of hydrogen available for combustion, results in the weights of the products of combustion being directly proportional to the heat developed. From the heat balances of a large number of tests worked up in the regular manner the writer finds that item 3, the loss in the products of combustion, will be approximately two per cent. of the heat of the fuel for each hundred degrees Fahrenheit, by which the temperature of the flue gases leaving the boiler exceeds that of the air entering the ashpit. Or, putting it in the form of a formula:

$$\textit{loss in products of combustion (in per cent.)} = 2 \times \frac{T_F - T_A}{100}$$

where

T_F = Temperature of gases leaving boiler;
F_A = Temperature of gases entering ashpit;

The excess air may be calculated from the gas analysis by the formula:

$$\textit{percentage of excess air} = \frac{O}{0.265\,N - O}$$

and

$$\textit{per cent. loss in excess air} = 1.70 \times \textit{per cent. excess air} \times \frac{T_F - T_A}{100}$$

In a similar way it has been found that

$$\textit{loss in unburned carbon monoxide (in per cent.)} = 60 \times \frac{CO}{CO_2 + CO}$$

Items 1, 2, 6 and 7 are calculated in the usual manner, but it will be found that the above three items correspond to the greater amount of work in figuring the heat balance and are the most important in judging of the performance of the boiler.

If possible, gas samples should occasionally be taken at the top of the first pass in a vertically baffled water-tube boiler, or at a point where air leakage through the setting has not had an opportunity to dilute the gases of combustion simultaneously with those at the uptake. The latter should be taken at the point where the temperature of the escaping flue gases is taken. This is especially important in obtaining an accurate heat balance, for, if the products of combustion become diluted by air leakage after passing the pyrometer and before reaching the sampling tube, the heat balance will show too high a loss up the stack and *vice versa*. If gas samples taken close to the fire along the path of the gases show a satisfactory and considerably higher CO_2 than those at the flue, this will indicate that the fireman is doing his work properly, but that the boiler setting is leaking badly. A tight setting should not allow over twenty-five to thirty per cent. excess air to leak in between the end of the first pass and the flue, and if more than this is found the cracks should be searched out with a candle and plugged. Old magnesia pipe covering made into a paste with water is satisfactory for this purpose.

The maximum permissible loss in the products of combustion varies somewhat with the equipment and conditions of operation, but it should seldom exceed nine per cent. unless the boilers are being forced to an unreasonable extent. A greater loss than this indicates dirty boilers, leaky baffles, or the carrying of such a thick fire that at times the gases burn all the way through the boiler, which can be determined by physical inspection.

The loss in excess air and that in unburned gas are somewhat dependent on each other, for as the latter is diminished, the former is increased. In general, it pays to keep the loss in unburned gases as low as possible. The point of best economy even with perfect firing will depend on the furnace volume and the rate of driving. With boilers set high above the grates it is possible to attain 15 per cent. CO_2 at 200 per cent. rating, giving not over 3 per cent. loss in excess air with a negligible quantity of carbon monoxide; in those set low a fireman usually has difficulty in averaging 11 or 12 per cent. CO_2 without making much carbon monoxide, even at low rates.

In general, a fireman's work can be considered satisfactory if the gas analyses show good CO_2 with an occasional 0.2 or 0.3 per cent. CO. Losses in unburned CO of over 1 per cent. are excessive and permissible only if the draft is limited and extreme capacity is required. Even in such cases steps should be taken to remedy the situation, for when a fire is being carried at the point where a slight amount of carbon monoxide is formed, it requires only a slight change in conditions to increase this sufficiently to cause a 10 to 20 per cent. loss.

With proper grates, losses due to carbon in the ashpit are largely under the control of the fireman and result from carelessness in cleaning fires, shaking the grates too much or from too much barring and working of the fires. Except when the grate is too coarse and entirely unsuited to the fuel or the coal clinkers badly, the refuse should not contain over 30 per cent. combustible with low-ash coals and less with those of higher ash content; hence, item 6 should not exceed 3 per cent. In endeavoring to lower this figure more is likely to be lost in excess air passing through holes in the fire than could be saved.

The last item (7) is obtained by difference and forms a valuable check on the test, especially in comparison with other tests, as any errors in the other items affect it directly. The absolute value of the radiation part seems rathe. uncertain, but for the whole item the values seem to range from 12 or 15 per cent. for small boilers

set singly and operated at rather low rates, to 7 or 8 per cent. for fair-sized units at average rates, down to 2 or 3 per cent. for very large boilers steaming at high rates, such as those at the Delray station of the Detroit Edison Co.

With the usual methods of gas analysis, losses due to unconsumed hydrogen, hydrocarbons, etc., also fall in this item and, if conditions are very bad, may increase it considerably. The writer's experience on a series of tests where conditions were such that there was a marked evolution of these gases, and the flue gases were carefully analyzed for them, was that these losses about equaled those due to unburned carbon monoxide; applying such a correction to other series of tests brought the radiation items into closer agreement.

As a rule item 2 (the loss due to latent heat) will be between 2.5 and 3 per cent., depending on the moisture content of the coal. It is an item entirely independent of the plant or operating force as it depends only on the quality of the fuel.

Summing up all these items, the writer would say from an extended experience in boiler tests that the following tabulation represents about what can be expected in the way of the "best," "good" and "poor" results under average power-plant conditions. Exceptional conditions, of course, may enable one to do somewhat better in some of the items:

Item	Title	Best	Good	—Poor—	
1	Heat utilized in evaporation	78.5	72.3	59.0	59.0
2	Loss due to latent heat	2.5	2.7	3.0	3.0
3	Loss in products of combustion	8.0	9.0	12.5	11.0
4	Loss in excess air	3.0	5.0	3.5	14.0
5	Loss due to unburned carbon monoxide	0.0	0.5	5.0	0.0
6	Loss due to unburned carbon in ashpit	2.0	3.0	5.0	5.0
7	Loss due to radiation, etc.	6.0	7.5	12.0	8.0

Two typical heat balances are shown in the "poor" column, the first where the losses are largely due to carrying too thick a fire with a waste of unburned gases; the second due to holes in the fire with high excess air and perhaps leaky baffles. These are by no means the worst the writer has encountered, but they are unfortunately too near the average of what occurs in many boiler plants.

H. D. Fisher.

Newton Highlands, Mass.

Stop for Gasoline Engine

The sketch shows a device employed to stop automatically a 12-hp. gasoline pumping engine in a railroad water station. The tank is about 6000 ft. from the pump house, and bolted to the roof of the former is a box 18 in. long and 4 in. square. A slot is cut lengthwise in it to allow a bolt to slide up and down, the end of the bolt being attached to a wooden float in the box. As the water level falls in the tank the bolt acts as a stop and allows the float to fall only a short distance. A copper point and one of the wires to the engine stop is fastened to the end of the float stem and a notched piece of copper, connected with the other wire, is attached to the roof of the tank directly over the float stem.

At the pumping station there is a small upright post carrying a hinged wooden lever. The latter is ordinarily supported in a horizontal position by the free end resting on a small projection of a second upright stick hinged at the lower end and carrying a piece of soft steel at the upper. An electro-magnet, placed near the soft steel, is connected in the tank circuit. There is also a switch in the line just above the horizontal lever. The latter carries a weight near the center and this switch is attached to the weight by a cord, as is also the switch in the ignition circuit.

When the water rises in the tank to the desired level and the copper contacts close the tank circuit, the electro-magnet is energized and attracts the piece of steel on

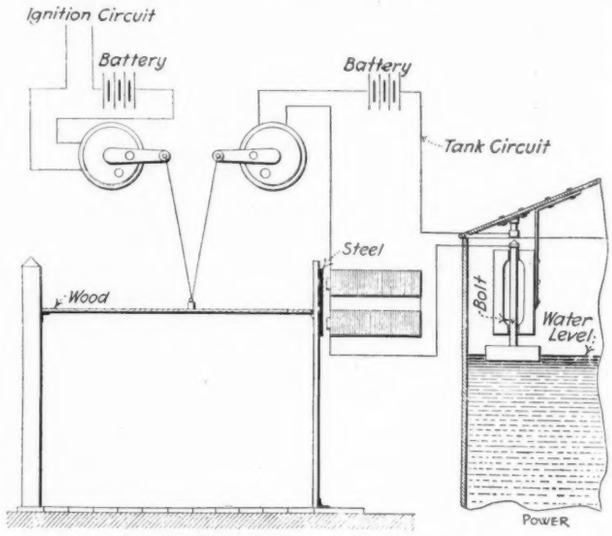


Diagram of Tripping Device and Circuits

the upright stick, thus releasing the weighted lever, which drops and pulls out both the switch on the tank circuit and the one on the engine circuit.

The current for the tank circuit is supplied by six dry cells and as the circuit is closed only long enough to cause the electro-magnet to act, the cells will last a long time. Aside from the wire used, the only outlay was 80 cents for the magnet, the rest of the material being picked up around the plant.

S. A. Standley.

Fort Wayne, Ind.

Attention of Firemen

On reading Mr. Dixon's comments in the Oct. 27 issue, under the heading "Poor Firemen," and which criticized the editorial, "Attention of Firemen," in the Sept. 15 issue, I referred to the latter issue and again read the editorial. I agree with Mr. Dixon. He quotes the case of a fireman traveling twenty-five miles three times a week to attend the evening sessions of a technical school. As Mr. Dixon says, it may be an extreme case, but it shows the spirit in this state.

Many industrial schools, which teach many kinds of trades and engineering are scattered over Massachusetts. There are evening sessions for day workers and special morning sessions for night workers. At the industrial school in this city we have four evening classes of eighteen pupils each, a morning class of seventeen, an evening class on the same lines at the local textile school with twelve pupils, and twenty pupils go once a week to a private school fourteen miles away; this makes a total of 121 men engaged in operating steam plants. This number includes men from coal passers to chief engineers, a large percentage being firemen.

It is a creditable showing for a city of 100,000.

John Powers.

New Bedford, Mass.

Emery around a Dynamo

Some time ago a correspondent in POWER stated that emery is a good conductor of electricity and for that reason should not be used on a commutator. This impression, which is held also by many power-station men, evidently is the result of expressions by certain well known authors, which would lead one to believe that emery is a conductor of electricity. I have always used emery cloth on commutators and have never had any trouble traceable to that source. Furthermore, I have tested emery and emery cloth repeatedly and have invariably been unable to find any that was a conductor of electricity.

Recently, to settle an argument with one of my engineers, I inserted both terminals of a magneto in a five-pound can of emery, but I could not ring through. We then placed some of the emery on a piece of paper and applied the terminals of the magneto, but the bell was silent. Finally, we brought the terminals closer and closer together and, to the engineer's astonishment, the bell would not ring until they had been brought into contact with one another. We repeated the experiment with emery cloth and got the same results.

I was taught early that copper dust would cause trouble and soon found out that, if any grinding was to be done around a commutator, it was much better to wait until the machine was dead. Furthermore, I found it well to immerse the emery cloth or sandpaper in thin, clean engine oil and then wipe off all of the oil with a clean rag. Of course, the emery cloth or sandpaper did not last as long, but I was quite sure that by employing this means no copper dust was liberated to get into the windings or back of the commutator lugs under the windings, such as to short-circuit the adjoining bars. Unquestionably, dust of any kind is a bad thing around electrical machinery, and for that reason, ordinarily, it is bad practice to grind commutators with emery cloth. However, an operating engineer is bound to run into a variety of circumstances and will find many times that oiled emery cloth is convenient for smoothing a balky commutator.

At present, I have a motor-driven exciter, upon which I have used emery for some time. It is applied with a block which just fits the periphery of the commutator. The machine is now running much better than when first installed; moreover, the commutator surface has a hard, mahogany appearance and requires practically no attention. My idea is to get a hard, glossy surface and then leave it entirely alone, not putting anything on the commutator. About all that is ever required is to remove the brushes one by one and wipe off the accumulated dust.

The worst feature of emery is that the grit becomes embedded in the copper and brushes, with a tendency to produce a continual cutting. However, if the brushes are removed before grinding and the commutator is carefully wiped off with a clean cloth saturated with new engine oil, no trouble should be had from that source. I would advocate the use of emery as follows:

1. Commutators worn out of round or cut should be turned off without delay, if conditions permit, and then ground to a hard glaze with oiled emery cloth. Use oiled sandpaper for the final finish and then turn the sandpaper over so as to buff the surface of the commutator. Never use a file on a commutator to any great extent—just enough to knock off the burrs of copper.

2. When using oiled emery cloth: Remove the brushes; use a wood block which fits the commutator snugly; pay particular attention to getting the proper speed for grinding; use high speed at the finish; do not forget to examine the mica between the commutator bars for bridges of copper; if the mica has been undercut, go over all the slots carefully and remove all dust.

3. Brushes: A brush which is good for one machine may be unfit for another; special brushes must receive careful adjustment of the spring tension; I have used a certain make of brush which increased the capacity of direct-current motors and generators more than 25 per cent. above the former "arcing-over" point.

4. Slotting of commutators: Not always a success; causes destructive chattering of brushes in many cases; destructive to high-grade, soft-composition brushes since it wears them away too fast; shallow undercutting of mica has given best results in most cases.

WALDO WEAVER.

Emporia, Kan.

Better Draft Regulation

In a certain plant there are two water-tube boilers, rated at 275 and 300 hp., respectively, which are connected to the same steam main. The smaller has a short straight pass to the stack and the larger is about 20 ft. from its stack. Each has one automatic damper and both are operated by the same damper regulator. The smaller unit had better draft and carried more than its share of the load. To correct this condition, extra dampers were so placed in both stacks that the fireman could control them and equalize the load. Another way would be to install a quick-acting damper regulator on the larger boiler which would act before the one on the smaller boiler, but the method used was the cheapest.

It is good practice when one damper is provided, and that controlled automatically, to install such an auxiliary damper. It should be within easy reach of the fireman, where it is more likely to be used. Otherwise, he may not close the damper when cleaning the fires, and then large quantities of cold air will be admitted through the open doors, causing serious strains and damage to the boiler and setting.

W. F. ROCKWELL.

Boston, Mass.

Repair Jobs with Iron Cement

As letters frequently appear on the use of various iron cements, my experience, while in charge of a plant in the West Indies, may help somebody.

The plant was condensing and had a rather antiquated rotative dry-vacuum pump for a spare unit. One day the air piston rod broke at the crosshead, the piston being driven back against the cylinder head. The force of the blow was not sufficient to break the head on the air-cylinder side, but it cracked the water jackets of the head on the outside. The cracks were radial from the center of the head and caused the cooling water to leak considerably.

We scraped off all the paint along the cracks to get the metal clean. Then we piped the water inlet of the head to the vacuum line from another pump and covered the other outlets with pieces of heavy sheet packing. Air was drawn in through the cracks in the head, which were covered with a fairly thin mixture of smooth-on cement; this was quickly drawn into the breaks and the

cracks were sealed after allowing the cement to harden. The pump has been operated regularly for three years and the water jacket does not leak.

By the same method, I was able to stop a leak in an 8-in. steam line, carrying 125 lb. steam pressure. This leak was around the threads at a flange in a section of the main which could be shut off from the rest of the system, but connected with a 238-hp. boiler.

One day, when the boiler was cold, I filled it with water and then, with all the valves closed, including the sectioning valve on the steam main, the pressure was taken from the leaking part. All the metal around the leak was cleaned as thoroughly as possible and the main valve opened. Next, the blowoff valve was opened wide, causing air to enter through the small leak. This air leakage was then stopped by a thin smooth-on paste as in the other case. When the steam was afterward turned into this section of the header there was no sign of a leak. Although this repair job was only meant to be temporary, it is still steam-tight after a year's service.

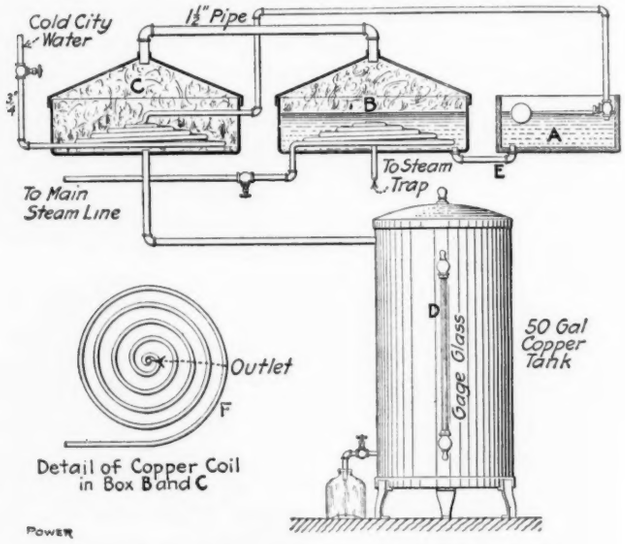
F. E. Meredith.

Boston, Mass.

Water-Distilling Apparatus

The sketch illustrates an apparatus for distilling city water for drinking purposes. The part *A* is an ordinary 8x18x10-in. watertight wooden box, containing a copper-ball float and valve for regulating the height of water in the box *B*, so as to cover the steam coil about 1 in.

The water from the box *A* flows by gravity to the box or evaporator *B*, through the connecting pipe *E*, connected from the bottom of *A* to *B*, thus insuring the steam coil in *B* being fully covered with water when in use.



Outfit for Evaporating Drinking Water

The evaporator *B* and the condenser *C* are round copper pans about 28 in. diameter by 8 in. deep, tinned on the inside and lagged on the outside with 1-in. magnesia asbestos pipe covering. In the bottom of the evaporator and condenser are two round, flat coils two pipes high, constructed of ¾-in. copper pipe well tinned on the outside. The top of the evaporator has a snug-fitting, funnel-shaped copper cover, with a 1½-in. outlet at the top, which connects with a similar arrangement on the condenser *C* by a 1½-in. pipe.

One end of the coil in *B* is connected to the main steam line with a globe valve between the coil and header, while the other end is connected to a steam trap. As the water boils in the evaporator *B*, it passes up and out through the 1½-in. pipe connection at the top and into *C*, where it is condensed when it comes in contact with the cold-water coil in the bottom.

The condensate then passes out by gravity through the 1-in. line in the bottom of *C* into the copper tank *D*, which is an ordinary 50-gal. tank, such as is used by lunch counters and restaurants to hold ice water.

The cold water in the coil in the condenser is not wasted. It is piped over to the box *A*, thereby saving a few heat units, as the water coming from the condenser coil is fairly warm; this materially helps the evaporator. From the tank *D* the distilled water is drawn off into 5-gal. bottles and distributed throughout the building to the water coolers as it is needed. By this home-made device we have saved much money on drinking water, as it was cheaper to distill water than to pay 10c. per gal. for it from some so called mineral-water company.

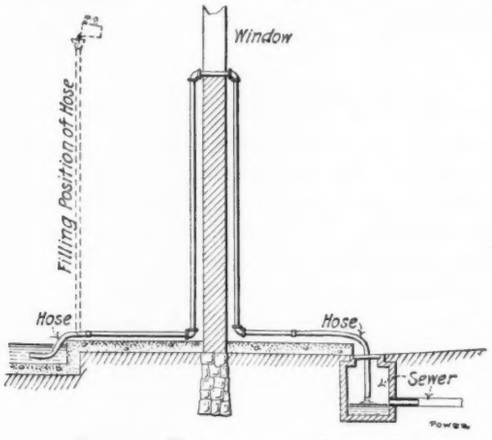
C. E. Anderson.

Chicago, Ill.

Starting a Siphon

The practice of filling a siphon and then opening the outlet to start it is well known. While effective under proper conditions, it is not always practical to use this method. The manner of starting here described and illustrated is efficient under most conditions and it permits the pipe line for the siphon to be arranged to best advantage before the siphon action is started.

Place the hose or pipe line in position, with its outlet end a few feet or so below the water level to be acted upon. Raise the inlet end above the highest level of the head to be overcome. The inlet is filled until the water begins to flow from the outlet. As soon as the flow occurs, the inlet end is closed and lowered into the water and reopened; this last operation will take but little time and it will not break the flow of the siphon.



Siphon Filled from Inlet End

While a hose is most desirable, it is not essential in all cases. Pipe may be used, it being only necessary to have it arranged to swing easily from a vertical to a horizontal position for the transfer of the inlet end from the filling to the drawing position.

A. P. Connor.

Washington, D. C.

Inquiries of General Interest

Value of Proximate vs. Ultimate Analyses of Fuel—Why is not the proximate analysis of fuel as reliable as the ultimate analysis for determining the heat value of a fuel?

T. W.

The proximate analysis gives the proportions of fixed carbon, volatile combustible matter, moisture and ash, and while it affords information as to the general characteristics of a fuel and relative value, the heat value cannot be directly computed from it as in an ultimate analysis because the volatile content varies widely in composition and heat value.

Distinguishing Iron from Steel—How can I distinguish wrought iron from steel by its appearance and without heating the material?

G. K.

The structure of steel will show an evener and finer grain than iron. By drawfiling the side of a rolled bar or plate of the material and applying an acid, iron will show a drawn-out, fibrous structure, while steel will exhibit a structure practically devoid of fibrous appearance.

Heating Surface per Lineal Foot of Pipe—What amount of heating surface is allowable per lineal foot of iron pipe of sizes used for steam heating coils?

B. J. W.

The sizes of iron pipes used for steam heating coils are usually from ¾ to 2 in. diameter, though 1 in. and 1¼ in. are the sizes most commonly employed.

1 lin.ft. of ¾-in. pipe has 0.2748 sq.ft. of heating surface.
1 lin.ft. of 1-in. pipe has 0.3442 sq.ft. of heating surface.
1 lin.ft. of 1¼-in. pipe has 0.4345 sq.ft. of heating surface.
1 lin.ft. of 1½-in. pipe has 0.4975 sq.ft. of heating surface.
1 lin.ft. of 2-in. pipe has 0.6218 sq.ft. of heating surface.

Taking Out Bag of Boiler Shell—When a bag has formed on the shell of a horizontal return-tubular boiler what objection, if any, would there be to heating the bagged part with a powerful torch and forcing the bag back into place by pressure or pounding from the outside?

A. B.

In the formation of a bag the sheet becomes stretched and reduced in thickness, and to restore the shell to its original form the bag cannot be removed without leaving a buckled surface except by an upsetting process of forcing the material back to its original form and thickness, employing a "hold back" or anvil on the inside. Although heating and straightening the sheet may be skillfully performed, the process is likely to impair the homogeneity and strength of the material and is therefore objectionable.

Delivery by Triplex Plunger Pump—Allowing 5 per cent. slippage, how many gallons per revolution of the crankshaft will be pumped by a geared triplex plunger pump having three plungers each 3 in. diameter and 4 in. stroke.

J. C. W.

The cross-sectional area of each plunger would be

$$3 \times 3 \times 0.7854 = 7.0686 \text{ sq.in.}$$

hence the displacement by each plunger would be

$$7.0686 \times 4 = 28.2744 \text{ cu.in. per stroke}$$

and as a gallon is equal to 231 cu.in., then for three plungers the displacement would be

$$\frac{28.2744 \times 3}{231} = 0.3672 \text{ gal. per revolution}$$

and allowing 5 per cent. slippage, the delivery would be

$$0.3672 \times (100 - 5) = 0.3488$$

or practically 0.35 gal. per revolution.

Variation of Pressure Required for Air Lift—In pumping from a well with an air lift, why is it necessary for the air supply to be about six pounds greater pressure in starting the lift than for keeping it in operation?

J. D. W.

The air pressure must be sufficient to overcome the hydrostatic pressure in the well at the point where the air first comes in contact with the water. During pumping, the flow to the well cannot sustain the same hydrostatic pressure as in the beginning of pumping and consequently a higher air pressure is required in starting the air lift than for keeping it in operation. This reduction of hydrostatic pressure is sometimes referred to as "drop" of the well and a reduction of 6-lb. pressure would be equivalent to a drop or a reduction of air-pipe submergence amounting to about.

$$6 \text{ ft.} \div 0.434 = 13.8 \text{ ft.}$$

Nitrogen Detrimental to Efficiency—In combustion of fuel, what part is taken by nitrogen contained in the air supply and contained in the fuel?

D. A.

The nitrogen contained in the air supply performs no useful office in combustion and passes through the furnace without change. It dilutes the air, absorbs the heat and reduces the temperature of combustion, and as each pound of air at atmospheric pressure contains about 0.7685 lb. of nitrogen it is the chief source of heat loss in furnaces. Nitrogen contained in the fuel, either free or in combination with other substances, is inert in the process of combustion, and as it absorbs heat without producing any benefit, its presence is detrimental. Since the specific heat of nitrogen is 0.2438, each pound of nitrogen, whether contained in the air supply or the fuel used, causes a loss of 0.2438 B.t.u. for each degree F. difference between the temperature of the chimney gases and the temperature of the air supply.

Relative Stress in Horizontal and Girth Seams—How is it explained that in a cylindrical shell the stress per unit of length of a girth seam is one-half as much as for a unit of length of a horizontal seam?

D. J.

The total stress resisted by a girth seam is equal to the pressure per square inch multiplied by the cross-sectional area of the shell in square inches, i.e.,

$$\text{pressure} \times \text{diameter} \times \text{diameter} \times 0.7854,$$

and as the length of the girth seam is diameter $\times$ 3.1416, then the stress per unit of length of a girth seam is

$$\frac{\text{pressure} \times \text{diameter} \times \text{diameter} \times 0.7854}{\text{diameter} \times 3.1416} = \frac{\text{pressure} \times \text{diameter}}{4} \quad \text{(a)}$$

The total stress resisted by a unit of length of a longitudinal seam is,

$$\text{one-half of (pressure} \times \text{diameter} \times 1) = \frac{\text{pressure} \times \text{diameter}}{2} \quad \text{(b)}$$

Comparing the values (a) and (b) it is seen that the stress per unit of length of a girth seam is one-half that for a unit of length of a horizontal seam.

Heating Surface of Return-Tubular Boiler—What is the method of calculating the heating surface of a return-tubular boiler 66 in. in diameter by 16 ft. long, containing 98 tubes, 3 in. diameter by 16 ft. long?

E. T.

The usual rule is to consider as heating surface all of the surfaces exposed to the flame or heated gas on one side and water on the other. This for return-tubular boilers with average brick settings will be approximately equivalent to (a) half the area of shell; plus (b) the area of the tubes; plus (c) the area of one head minus twice the total cross-sectional area of the tubes. Taking all dimensions in inches, one-half of the area of the shell would be

$$\frac{66 \text{ in.} \times 3.1416 \times (16 \times 12)}{2} = 19{,}905.1 \text{ sq.in.} \quad \text{(a)}$$

The internal diameter of a standard 3-in. boiler tube being 2.782 in., the internal area of the tubes would be

$$2.782 \times 3.1416 \times (16 \times 12) \times 98 = 164{,}450.5 \text{ sq.in.} \quad \text{(b)}$$

The gross area of one head would be

$$66 \times 66 \times 0.7854 = 3421.2 \text{ sq.in.}$$

and as the total cross-sectional area of the tubes would be

$$(2.782 \times 2.782 \times 0.7854) \times 98 = 595.7 \text{ sq.in.}$$

the heating surface of the heads would be taken as equivalent to

$$3421.2 - (595.7 \times 2) = 2229.8 \text{ sq.in.} \quad \text{(c)}$$

Adding results (a), (b) and (c) gives

$$19{,}905.1 + 164{,}450.5 + 2229.8 = 186{,}585.4 \text{ sq.in.}$$

or

$$\frac{186{,}585.4}{144} = 1295.7 \text{ sq.ft. of heating surface.}$$

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for inquiries to receive attention.—EDITOR.]

Engineers' Study Course

Problems in Power-Plant Design--IX

Hot-Blast Heating in Machine Shop and Foundry

Although direct radiation is used to some extent in buildings of this kind, it is not well adapted to those of large size and of modern construction. It provides no means of ventilation, except by air leakage, and when used in buildings having a large glass exposure, such a quantity of radiating surface is required that certain parts are apt to become overheated. This is especially true in those having a considerable height with galleries and monitor roof as in Figs. 2 and 6. In cases of this kind the heat rises rapidly to the upper part of the building overheating it and increasing the transmission through the roof, while the space near the floor remains too cold for comfort, except near the coils, where it is likely to be excessively hot. In some departments, however, direct coils may be used to advantage, either alone or in combination with a ventilating fan. In most large manufacturing buildings, at the present time, the fan system is employed, being especially adapted to this class of work. With this arrangement, the warm air may be so distributed as to heat the space evenly, and at the same time provide an abundance of fresh air for ventilation. When the supply of exhaust steam is limited, the heating plant is usually designed to recirculate the air within the building in the coldest weather, admitting more and more fresh air as the outside temperature rises.

The location of the apparatus and the method of distributing the air will depend somewhat upon the type and construction of the building. A plan commonly adopted in machine shops of brick and steel construction is to place the fan and heater overhead and carry distributing ducts of galvanized iron through the roof trusses. From here, branches are brought down on posts and the air discharged directly downward or at an angle so as to throw the greater part toward the outer walls. If the width of the bays is less than 20 ft., this plan works well with the discharge outlets about 5 or 6 ft. from the floor. If the air must be thrown a greater distance the outlets should be placed at a higher elevation and the angle from the vertical increased. By this means it is possible to maintain a stratum of warm air near the floor where it is most needed. When the central part of the building is used for erecting or other purposes, where a certain number of workmen are employed, a smaller amount of air should be discharged in this direction.

If the plant is designed for recirculation of air for the total heating in the coldest weather, return ducts should be provided with openings near the floor along the outer wall; otherwise the circulation will be local and the more distant parts of the building will not be reached. It is not generally necessary to provide any mechanical means for the discharge ventilation, as this may be taken care of by leakage, and through the monitor windows in mild weather.

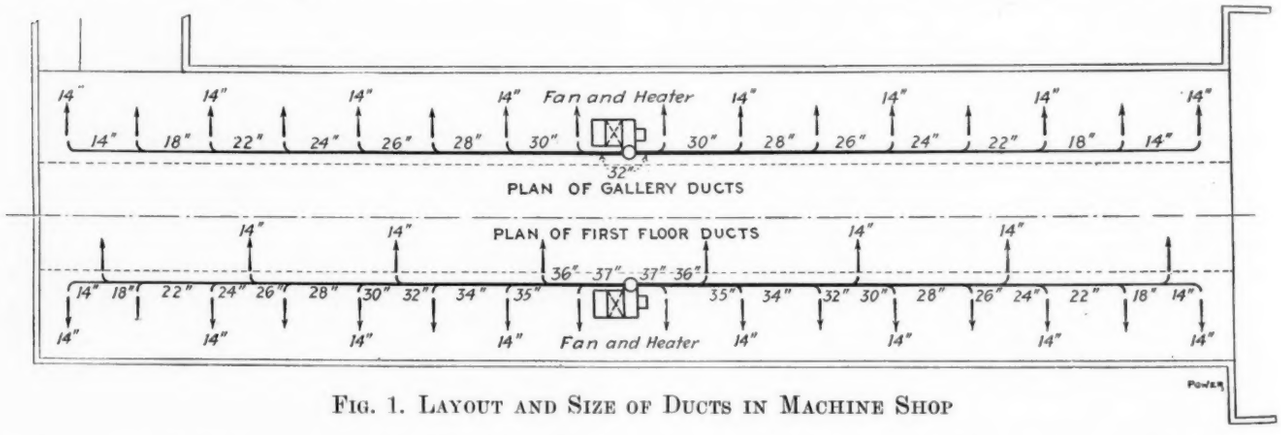


Fig. 1. Layout and Size of Ducts in Machine Shop

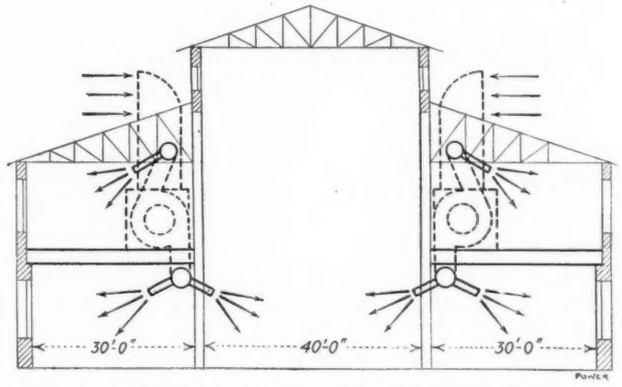


Fig. 2. Sectional Elevation, Showing Fans on Galleries

In the case of foundries the conditions are somewhat different, as the air at times is filled with steam and heavy gases, and it is advisable to provide an exhaust fan. Here, ventilation by monitor windows only serves to make conditions worse, as the entering cold air causes the steam to condense on the walls and overhead construction and drip

to the floor. In general, the air in foundry work should be delivered at an angle downward toward the outer walls and removed through vents near the floor along the central aisle or bay.

Having considered the subject briefly, let us apply it to the case in hand and decide upon the best arrangement to employ. All computations relating to the fans and heaters have been worked out in a previous article, so that only the location of the fans, and the method of

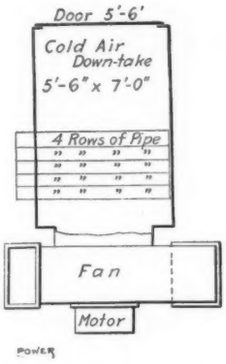


FIG. 3. PLAN OF FAN AND HEATER

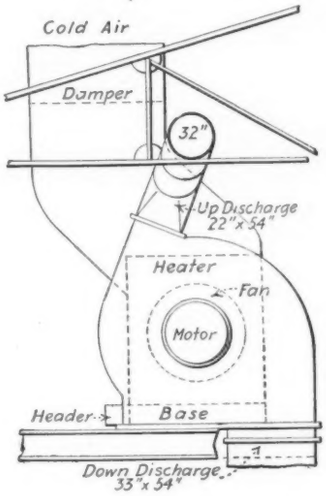


FIG. 4. ELEVATION OF FAN, GIVING SIZE OF OUTLETS

running the distributing ducts, need be considered at the present time.

MACHINE SHOP

The general arrangement of the heating apparatus for this building is shown in plan in Fig. 1 and in sectional elevation in Fig. 2. The units are placed on the gallery level, one on either side, about midway. Each fan has two discharge outlets one up and the other down, connecting with two sets of horizontal distributing ducts or mains running the entire length of the building and located as shown in Fig. 2. As the width of the outer bays is more than 20 ft., it is necessary to deliver the air at a fairly high elevation in order to reach the outer wall. The

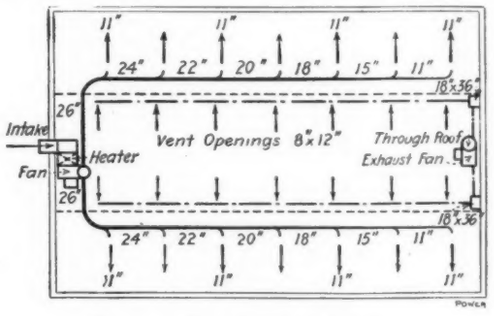


FIG. 5. PLAN OF FOUNDRY

arrangement upon the first and second floors is practically the same except in case of the former a certain amount of air is blown into the central part of the building. The relative supply of air to different parts of the building is as follows:

Outer bays, first floor, two-fifths; central bay, one-fifth; galleries, two-fifths. The outlets are approximately 25 ft. apart in the galleries and outer bays, and 50 ft. apart for the central portion.

The fresh air is supplied through special flues extending through the roof and arranged to take in the air on the side away from the monitor windows. These inlets should be provided with louvers and strong wire netting to keep out storm, leaves, birds, etc. Dampers should be placed in the downtakes above the heaters for closing when the fans are not running. A plan and elevation of the fan and heater arrangement are shown in Figs. 3 and 4 respectively. As there is an abundance of exhaust steam available in the present case, the air will always be taken from outside, except perhaps at special times when it is desired to heat the building quickly in the morning or in extremely cold weather when the temperature drops considerably below zero.

Under these conditions it has not seemed necessary to provide return ducts, but large doors have been placed in the heater casings so that the air can be recirculated if desired. This arrangement will be satisfactory for occasional use although the circulation will not be so complete as with a return duct.

There are two common ways of determining the size of the distributing ducts. One is to allow a velocity of 2000 to 3000 ft. per min. in the trunk lines, reducing to 1200 or 1800 ft. in the branches, according to the length of run. When the air is discharged from a considerable height, as in Fig. 2, the velocity should be fairly high so

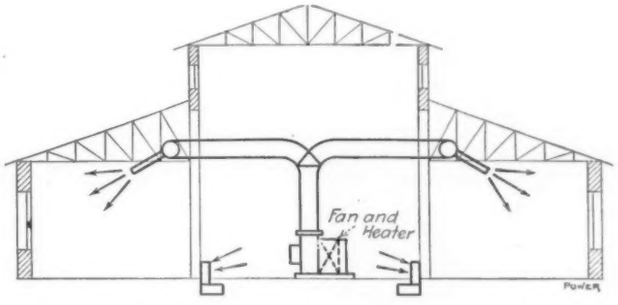


FIG. 6. TRANSVERSE SECTION THROUGH FOUNDRY

that the air will reach the outer walls. Another method, and the one employed in the present case, is to make the area of the main duct the same as the discharge outlet of the fan, and proportion the branches according to the factors given in Table 1.

In the last lesson the outlet area of an 8-ft. fan was given as 18.6 sq.ft. while a catalog of standard make gives it as 20.2 sq.ft. For present purposes we will take it as 20. Referring to Fig. 1, there are 24 outlets from the lower air duct, so that the areas of the bottom and top outlets from the fan casing must be in the ratio of 24 to 16 or 3 to 2. If the total area is 20 sq.ft., then the two outlets must have areas of 12 sq.ft. and 8 sq.ft., respectively. The width of fan casing is given in the catalog referred to as 4.5 ft., so the outlets may both be made this width, with the other dimensions

$$12 \div 4.5 = 2.7 \text{ ft.}$$
$$8 \div 4.5 = 1.8 \text{ ft.}$$

which expressed in inches, gives dimensions of 33×54 in. and 22×54 in., respectively.

Next, let us determine the size of the ducts by the use of Table 1.

TABLE 1—DUCT DIAMETERS AND CORRESPONDING FACTORS*

Dia. of Pipe, In.	Factor	Dia. of Pipe, In.	Factor
6	88	22	2,290
7	130	24	2,845
8	180	26	3,470
9	244	28	4,175
10	316	30	4,960
12	500	36	7.800
14	733	42	11,400
16	1,032	48	16,000
18	1,385	54	21,400
20	1,800	60	28,000

*Abridged from the "Metal Worker."

Taking the upper duct first, the fan has an outlet of 8 sq.ft., which is nearly the area of a 40-in. round pipe. The nearest size to this in the table is 42 in., which has a factor of 11,400. This duct has 16 outlets in its entire length, so

$$11{,}400 \div 16 = 712$$

is the factor to look for in the table in determining the size of outlets and we find it corresponds to a 14-in. pipe.

In finding the size of the two main branches as they separate above the fan, a factor of 5700 is obtained by dividing 11,400 by 2, which comes between a 30-in. and 36-in. pipe, but may be safely estimated as 32 in. Proceeding in like manner the dimensions for the entire duct were obtained and marked on the plan in Fig. 1.

The lower outlet has an area of 12 sq.ft., which corresponds nearly to a 48-in. pipe, or a factor of 16,000 Dividing this by 2, and proceeding as above the factor is 8000, and this corresponds to a 37-in. pipe as nearly as can be estimated. Using 14-in. outlets, the same as for the upper duct, the required dimensions of the main are found to be as marked in the drawing, Fig. 1. Each outlet should be flared to about 20 in. in diameter at the mouth and provided with an adjustable damper operated by chains from the floor.

Foundry

The general arrangement of the heating and ventilating apparatus for the foundry is shown in Figs. 5 and 6. The fan and heater are located on the floor at one end of

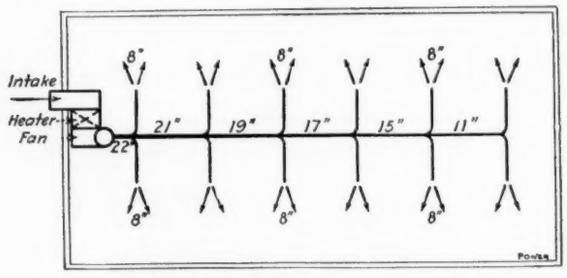


Fig. 7. Hot-Blast System in Forge Shop

the building and the fresh air drawn in through a flue carried up about 10 ft. on the outside of the building. The method of air distribution is practically the same as for the machine shop, but in this case an exhaust fan is provided. The vent ducts are carried beneath the floor and the outlet openings are placed against the posts on either side of the central aisle or bay. The vent fan is suspended from the roof trusses at the other end of the building, above the main doors, and is thus well out of the way. The underground ducts are of cement and all overhead piping of galvanized iron.

Pipe sizes for the overhead distribution were computed in the same manner as for the machine shop, and are indicated on the drawing. Connections between the vent registers and the exhaust fan are proportioned on a basis of 1200 ft. per min. velocity.

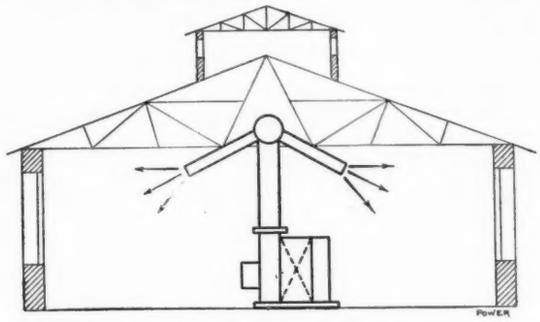


Fig. 8. Forge Shop in Section

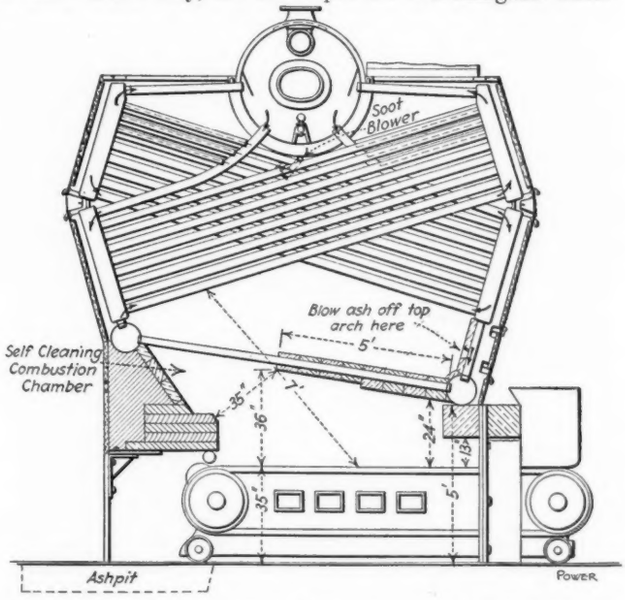
All inlets and outlets are provided with regulating dampers for equalizing the flow of air.

Forge Shop

The arrangement for the forge shop is practically the same as for the foundry, except that the exhaust fan is omitted. By this method the monitor windows are depended upon for discharge ventilation. Blowing the air against the outer walls tends to prevent the smoke from collecting under the eaves and drives it into the monitor. Sometimes an exhaust is provided for winter use if too much heat is carried off through the monitor windows.

New Setting for Worthington Boiler

The furnace setting shown in the accompanying illustration has been devised recently by James Beggs & Co., of New York City, for its improved Worthington water-



New Setting for the Worthington Water-Tube Boiler

tube boiler, reverberatory-arch furnace type, in connection with an automatic chain-grate stoker.

One of the mud drums is set at a lower level, thus the tubes which connect the two mud drums are inclined at the proper angle to promote circulation and protect the tubes.

The reverberatory arch is formed by covering these tubes at one end with special C-shape fire tile.

The illustration shows the stoker under the lower mud drum, which establishes that side as the front of the boiler.

This arrangement gives ample flame travel and a large combustion chamber above the arch; from the center of the grate to the bottom tubes of the sections the distance is 7 ft.

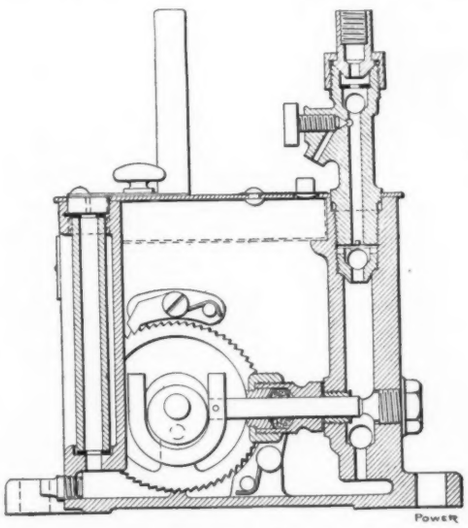
The furnace has been specially designed to prevent smoke from volatile coal, such as is burned in the Middle West, and possesses the additional advantage of a self-cleaning combustion chamber. By means of a steam blower below the steam drum in the bank of the tubes and one above the arch the soot from the tubes may be blown into the ashpit at the rear of the boiler.

The boiler shown in the drawing is rated at 300 hp. The depth of the setting is 14 ft. 6 in., the width 9 ft. 7 in. and the height from the floor to the top of the steam drum 15 ft. 9 in. With the exception of the width, these same dimensions apply to any boiler between the ratings of 200 and 600 hp., additional capacity being obtained by adding on more sections of tubes to the width.

McCord One-Feed Lubricator

This class "T" lubricator is so designed that all its working parts run in oil, thus reducing wear to a minimum. It is automatic in action and forces a flow of oil with the first stroke of the engine to which it is attached. The mechanism is shown in the accompanying illustration.

The shaft carrying the ratchet gear also carries an eccentric to give motion to the pump plunger which



SECTION THROUGH LUBRICATOR

forces the oil past the two upper ball-check valves, between which is a bleeder showing the quantity of oil being pumped.

The pump, of one-, two- and three-pint capacity, has a heater cast in one corner of the reservoir for heating the oil in cold weather. It is made by the McCord Manufacturing Co., 2587 Grand Boulevard, East, Detroit, Mich.

OVER THE SPILLWAY

JUST JESTS, JABS, JOSHES AND JUMBLES

"Washington officials look for an increase in immigration after the war to 24,000,000 new arrivals a year." Gracious Scott! what if one in every twenty-four is an operating engineer!

Now it is said that one of the nations at war is using the copper parts of old locomotives, including the boiler tubes, in the gun foundries. Some wise geek has been over here and witnessed the high explosiveness of our tubes and cribbed the idee.

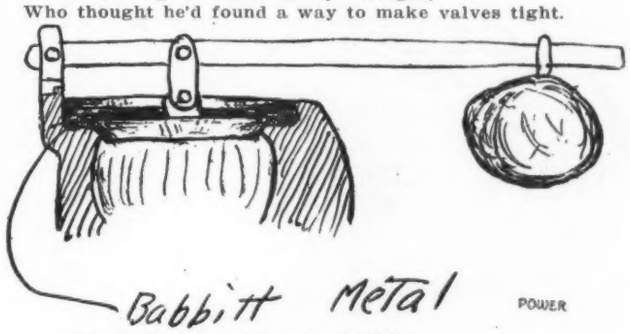
Down Missouri way, it is recommended that every child be given a pig, to be brought up according to pig etiquette. "The boy who sticks to the hog game is headed down Prosperity Avenue," says that state's board of agriculture. Some folks take naturally to hogging it and others have it thrust upon them. This Missouri thing listens like a thrust.

We love our Chicago for many things, but— Well, sometimes it fails to bottle up the enemy. At the teachers' convention an "educator" advised that "O. Henry will take the place of Milton; President Wilson's address to Congress will replace Shakespeare. Shakespeare will be used sparingly, mixed with Bernard Shaw and Oscar Wilde."

Poor old Bill! "Mixed" with B. Pshaw and O. Wilde, Bill will look like a colyum of jokes in Kent's Handbook.

IN MEMORIAM

A luckless engineer was "Lefty" Wright,
Who thought he'd found a way to make valves tight.



So he "fixed" one with some babbitt
Ere his comrades saw him grab it—
And the pillow that they sent him read: "Good Night!"

Who says the workman's compensation law does not reach far enough? Only the other day a sufferer got $210 just because his boss set him in contact with a live lobster and neglected to say that the line was not dead. Rubber gloves might have saved a perfectly good thumb-end and 210 passable dollars.

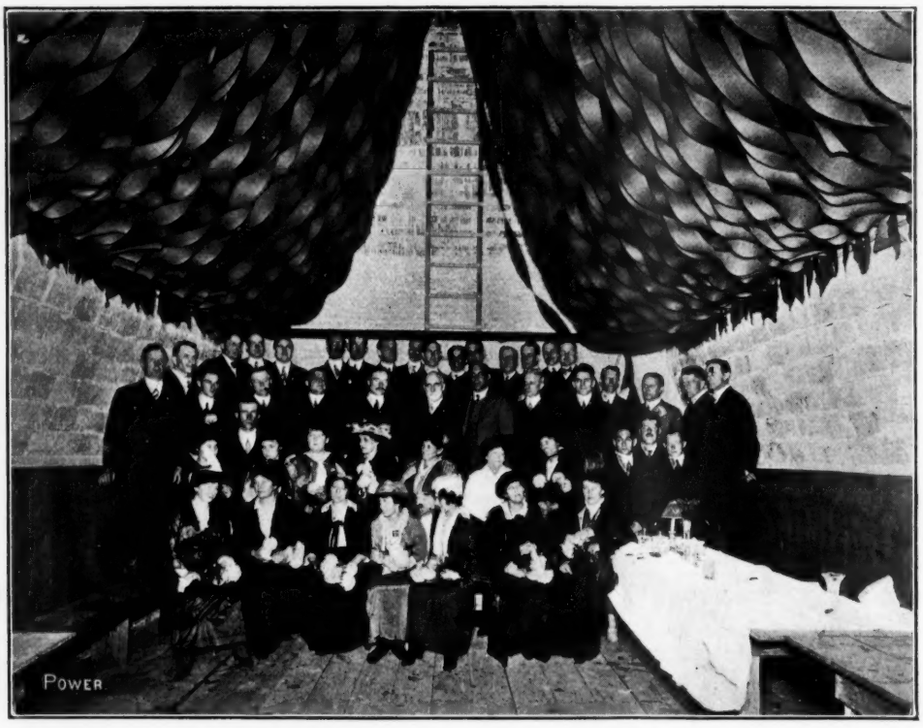
Here are a few "rules" posted in the engine room of the Globe Iron Co., Jackson, Ohio:

1. When you enter the engine room spit on the floor; we have water, lye, soap, mops and brushes and will clean up as soon as you leave.
2. Rub your hands on all the polished work; it will give some one work and use the surplus polish.
3. Put your hand on the engine's bright work; you will then know if it is smooth, hot or cold. Tell others to do the same.
4. Stay in the engine room as long as you please. The engineer has nothing to do but entertain visitors.
5. Be sure to tell the engineer if his engine is pounding or running right; as he will not know it unless you do. He will stop and make repairs while you wait.
6. Don't tell the engineer who you are; he is a mind reader and always knows you. Go anywhere in the engine room and you will please him.
7. Advise him what to do, as you know best; the engineer is there only every day and does not have a chance to see as much as you will in an hour.
8. If the engineer is busy making repairs, tell him a good story you heard the other day, and if possible get in his way.

Banquet in a Boiler Furnace

It is not uncommon to read of banquets held amid unusual surroundings, generally typifying the object of the occasion; but in serving a dinner to forty-six persons inside a boiler furnace, the Edison Illuminating Co. of Detroit appears to have eclipsed all previous efforts.

The occasion was the celebration of the completion of boiler No. 1 at the new Conners Creek plant of the company. This boiler is similar to the nine already in operation at the Delray station, which have already been described in these columns. They are the largest boilers in the world, and in the new plant each will regularly supply 10,000 kw. at the turbines. The setting occupies a space 30 ft. cube, and an idea of the size of the furnace will be had from the photograph. The combustion chamber was floored over and the guests were admitted through the ashpit, a section of the dump grate having been removed to permit installing a flight of stairs. The streamers were hung for decorative purposes, but follow approximately the line of the tubes.



GUESTS ASSEMBLED IN BOILER FURNACE

Regulations Governing Refrigerants in New York City

The following regulations of the fire prevention bureau of the New York City fire department go into effect Jan. 1, 1915.

REFRIGERATING PLANTS AND REFRIGERANTS

Section 490-A: It shall be unlawful to operate within the City of New York any plant producing refrigeration by means of gases under pressure in connection with cold-storage plants, breweries, ice manufactories, hotels, restaurants or other places without a permit from the fire commissioner.

Section 490-B: Each refrigerating plant shall be equipped with an emergency pipe or pipes by which, in case of accident, the pipes under pressure can be discharged by a valve, which can be opened both inside and outside of the refrigerating plant into water, or be brought into contact with sufficient water to absorb and carry off all gases so discharged. At the discretion of the fire commissioner, the said emergency pipe or pipes may conduct the gases to a point at least 10 ft. above the roofs of adjacent buildings into the open air.

Section 490-C: All refrigerating machines shall be equipped with automatic safety devices, which discharge at 300 lb. pressure to the square inch for ammonia, 1400 lb. for carbon dioxide, 100 lb. for sulphur dioxide, and 100 lb. for ethyl chloride into the emergency pipes required by the preceding section, or into the low-pressure side.

Section 490-D: In refrigerating plants built and erected after Jan. 1, 1915, every room containing pipes carrying a refrigerating chemical under pressure exceeding 40 lb. for ethyl chloride, 60 lb. for sulphur dioxide, 100 lb. for ammonia and 500 lb. for carbon dioxide, and which by accident may become filled with the gases generated by said chemicals, shall have an exit to the open air direct or by means of stairway, or to a room or hall from which said gases can be excluded. Other refrigerating plants shall be provided with such means of exit as the fire commissioner may prescribe. Rooms which contain only the liquid supply pipe to the refrigerating coils are not included within the meaning of this section.

Section 490-E: The maximum pressure allowed in refrigerating machines shall not exceed 300 lb. for ammonia, 1400 lb. for carbon dioxide, 100 lb. for sulphur dioxide and 100 lb. for ethyl chloride. All pipes used for refrigerating purposes shall stand a hydrostatic test of at least double the maximum pressure per square inch specified under Section 490-C. All fittings used must be guaranteed to stand a pressure of at least three times the maximum pressure per square inch specified under Section 490-C.

Section 490-F: No room containing refrigerating pipes under pressure shall have in it any open flame, arc lights or direct openings into the boiler room. There shall be a wall between such room and the boiler room equipped with a self-closing door. Internal-combustion engines may be started in the usual manner.

Section 490-G: In such large refrigerating plants as may be designated by the fire commissioner, there shall be kept, fit and available for use, suitable helmets which will permit the wearer to reach, without suffocation, any part of the refrigerating system.

Section 490-H: In all refrigerating plants the pipes in the engine room shall have conspicuous signs displayed at proper places designating in easily legible letters the name of the refrigerating chemical contained therein.

Section 490-I: In all refrigerating plants there shall be posted several copies of a brief set of rules satisfactory to the fire commissioner, directing all employees as to their duties in case of fire or other emergencies. Employers shall be responsible for the proper drilling of all employees in such emergency duties.

Section 490-J: Refrigerating plants may store a surplus stock of the refrigerating chemical of two cylinders, or, if necessary, a quantity not to exceed 10 per cent. of the charge of the plant. No cylinder containing gas under pressure shall be stored in the boiler room.

Section 490-K: No refrigerating machine of over three tons refrigerating capacity shall be operated unless under the charge of a person holding a certificate of fitness from the fire commissioner.

Section 490-L: Fire department fee for permit—10 tons refrigerating capacity or less, $2; 10 to 50 tons refrigerating capacity, $5; over 50 tons refrigerating capacity, $10.

Section 490-M: The fire commissioner may exempt from the provisions of these regulations refrigerating machines of less than three tons refrigerating capacity, provided a certificate of approval has been issued for such machines.

[Editorial comment on these rules is made on page 849 of this issue, and the discussion of them before the recent meeting of the American Society of Refrigerating Engineers appears on page 866.—EDITOR.]

Mechanical Engineers' Convention

The 35th annual meeting of the American Society of Mechanical Engineers, held at the Engineering Societies Building, New York, Dec. 1-4, emphasized more, than has any previous meeting, the relation of the engineer to the body politic, and the importance of the engineer in the public service. It enlisted interest and attracted attention, therefore, from a wider circle than have meetings devoted more strictly to the methods and details of the work of the profession, and should have an important effect upon the progress of the movement to obtain a wider appreciation and recognition of the engineer as a factor in big enterprises and in public affairs.

The keynote to this was sounded in the address of the retiring president, James Hartness, which dealt with "The Human Element—the Key to Economic Problems." An entire day was devoted to a Public Service Session, which was opened by Hon. John Purroy Mitchel, mayor of New York; addressed by Andrew Carnegie, and attended by mayors, commissioners and the heads of many municipal departments. The committee appointed by the Society to Formulate Standard Specifications for the Construction of Steam Boilers and other Pressure Vessels and for their Care in Service presented a progress report, the discussion of which occupied the attention of the whole Society during Wednesday forenoon and continued in well attended sessions throughout the week. The code which this committee is preparing is designed to be the basis of uniform legislative regulation in all the states. Such regulation involves many interests, is accepted reluctantly by some, while all are keenly watchful for features which may possibly affect them prejudicially. It has been a harrowing task to overcome opposition, to reconcile conflicting interests and to evolve a code which should eliminate doubtful design and construction and favor safe and intelligent operation without putting an insupportable burden upon present installations and the users of existing methods, but the hearings of this meeting were characterized by an evident acceptance of the fact that the work must be done, and by a united effort to do it in the best possible manner, so that, as Chairman Stevens expressed it, "we may have in the future a little better boiler for a little more money and less reckless disregard for human life."

It is expected that the committee will be able to present its recommendations, revised in the light of the discussions and in final form at the spring meeting of the Society.

The meeting was not lacking in more technical material. The papers interesting to "Power" readers: "The Design and Operation of the Cleveland Municipal Electric Light Plant," by Frederick W. Ballard, engineer of construction for the plant; "A Rate Flow Meter," by H. C. Hayes; "Laboratory for Testing and Investigating Liquid Flow Meters of Large Capacity," by W. S. Giele, of the Harrison Safety Boiler Works; "A New Volume Regulator for Air Compressors," by Ragnar Wikander; "The Clinkering of Coal," by Prof. Lionel S. Marks, of Harvard University, and "Damages for Loss of Water Power," by F. W. Dean, as well as the discussion of the Boiler Specifications Code, will be treated in future issues.

OPENING SESSION

The formal opening of the meeting took place Tuesday evening with the address of President James Hartness, an abstract of which follows:

THE HUMAN ELEMENT—THE KEY TO ECONOMIC PROBLEMS

In his address on the above subject the president points out that the world of mechanism has become so intricate and complex that it has gone beyond the capacity of any single individual, that each one must be content to comprehend only a small part, and that it is only by selecting the character and limiting the amount of material that is taken into our individual minds that we can hope to accomplish the best results. We should not overload our minds with data to the exclusion of thoughts of an initiative character.

Man is a creature of habit, and the most efficient use of mind and body demands a scheme of life that permits each one to take advantage of this fact. Specialization and repetition, by which habit is formed, are both essential to success.

Carrying the principles of the individual into the realm of organized industry, it is a fact that large organizations are essential as affording an opportunity for the most complete subdivision of work and the greatest degree of specialization, both of which lead to the most effective employment of human energy. Antagonism to the large organizations should be directed against corrupt practices, and not against the organization itself, which involves the workers' interest. The greatest good to the greatest number requires that we take into consideration each human being, his desires and his needs in finding the work for which he is best endowed.

The large industrial plant, to be ideal, should have a capital as large as any competing organization, a small harmonious board of directors with an able leader, and an able staff of officers, the chief executive of which should combine a knowledge of the technical and business side of the industry with the fullest possible conception of the human element. Long continuity in service should be given the first place in the scheme of management. Each position throughout the entire organization should be filled with someone who considers that position the best in the world for him. Each officer and each workman should have a live interest in his part of the work. Each one should by specialization become the most efficient in his particular work. The interest of the officer or worker should be maintained by some fitting stimulus, and each one should be protected so far as possible from influences calculated to induce discontent.

Surely the investor should look with distrust upon a management that is always changing officers, changing men, changing models, changing methods without regard to the inertia of habit and the human element which is the life blood of every organization. He would also look with doubt on any scheme of management that allows the careless employment and discharge of men without due regard to the loss involved by such changes, for the perpetual changing of men is equivalent to the change of character of work in its handicap to industrial efficiency.

Following the address came the report of the tellers of election of officers, which announced the election of Dr. John A. Brashear as president; Henry Hess, James E. Sague and George W. Dickie as vice-presidents, and Charles T. Main, Spencer Miller, Max Toltz and Morris L. Cooke as managers.

The annual reception to the president, president-elect, members and guests, followed by dancing and a collation in the Society's rooms, concluded the evening's program.

WEDNESDAY

After the business meeting on Wednesday morning, the professional sessions opened with the following papers: "Floor Surfaces in Fireproof Buildings," by S. E. Thompson; "Reinforced Concrete Factory Buildings," by F. W. Dean; "Measuring Efficiency," by H. L. Gantt; "Standardization in the Factory," by C. B. Auel; "Operation of Grinding Wheels in Machine Grinding," by G. E. Alden, and "Friction Losses in the Universal Joint," by P. F. Walker and W. J. Malcolmson.

At the simultaneous session of the railroad section, the report of the sub-committee on railroads was submitted, dealing with "Steam Locomotives of Today."

The ladies held a reception and Thé Dansant from 4 to 6 p.m. in the Society's rooms.

Wednesday evening the award of the John Fritz Medal was made to Prof. John E. Sweet, of Syracuse, N. Y., honorary member and past-president of the Society, "in recognition of his achievements in machine design and his pioneer work in applying sound engineering principles to the construction and development of the high-speed steam engine."

Addresses were delivered by Dr. James Douglas, honorary member and past-president of the American Institute of Mining Engineers, and Dr. S. W. Stratton, director of the Bureau of Standards.

THURSDAY

A new feature of the professional program was a session devoted exclusively to public-service problems. This occupied all day Thursday and was opened with an address by Mayor Mitchel, of New York, who spoke on the important rôle of the engineer in municipal affairs. In this connection, he referred to the Bureau of Efficiency which he established some time ago and which has done excellent work in eliminating lost motion among the city departments and in standardizing methods, costs, etc. This is essentially an engineering bureau.

Following the mayor, Andrew Carnegie made a few remarks on the debt which society in general owes the engineer, and then indulged in a few pleasantries with President-elect Brashear, who replied in kind.

The first regular paper of this session was prepared by Henry Bruère, city chamberlain, who dealt with "The Future of the Police Arm from an Engineering Standpoint." Con-

sidered in their special applications, police work and engineering appear to have little in common, but as viewed in a broader sense, Mr. Bruère pointed out the urgent necessity for engineering methods in police work; that is, the latter should be developed on scientific lines, and in place of cunning and cudgels there must be substituted a policy based upon a knowledge of needs, feasible standards of service and an organization capable of attaining them.

Morris S. Cooke, Director of Public Works, City of Philadelphia, next spoke on "Some Factors in Municipal Engineering," calling attention to the opportunity for engineers in municipal work and to the fact that at present a large part of this field is covered by nontechnical men. Contrary to the theory of civil service, the best men seldom apply for the more important positions, and it then becomes necessary to go out and find them, offering such inducements as will attract the right man for the place. In such cases, the appointing officer, through some form of merit system or otherwise, should be given a freer hand in making selections. As a safeguard, the author believed the four national engineering societies might act in an advisory capacity to federal, state and municipal civil service commissions.

Further, the effectiveness of the engineer in public employ is largely dependent upon the support accorded him by his profession in the education of the public to proper policies of administration. Too many matters that should be determined by technical and scientific considerations are now decided by vote, of which the control of the budget in many municipalities affords a striking example.

As a citation of one instance in which the engineer is being properly recognized, Edward Flad offered extracts from the new charter of St. Louis, by which a Board of Public Service is created, composed of a president and four directors, two of which must be engineers of technical training.

"The Engineer and Publicity" was the title of the next paper. In this, C. E. Drayer, of Cleveland, pointed out the opportunity of rendering service to the public by giving it dependable information about technical subjects. One rea son for the general lack of engineering news in the daily newspapers is that the ordinary reporter lacks the necessary technical knowledge to handle it. The speaker referred to the excellent work now being done by the Cleveland Engineering Society in coöperating with the editors of local papers and supplying engineering items of a popular nature. He believed the work might be extended and carried on broadly through the medium of magazines, pamphlets and the lecture platform, in addition to the daily newspapers.

A paper that attracted unusual attention was "The Design and Operation of the Cleveland Municipal Electric Light Plant,"* by F. W. Ballard. This 25,000-kw. plant, the largest of its kind in the country, went into operation last July and supplies not only city light and power, but also commercial service at extremely low rates, ranging from a maximum of 3c. to a minimum of 1c. per kw.-hr. Based on an annual output of 60,000,000 kw.-hr. and a total plant investment of $3,000,000, the fixed charges, at 9 per cent., would amount to $0.0034 per kw.-hr.; the coal at $0.002 per kw.-hr.; the station costs exclusive of coal at $0.0015, and the distribution costs, exclusive of fixed charges, at $0.004 per kw.-hr. Adding to this, administration charges at $0.0005 and profits at 8 per cent. on the investment, makes the total average cost per kilowatt-hour generated, $0.0165.

The past three months' operation of the plant and the tests that have been conducted indicate that these estimates will be attained.

The remaining papers of this session were "The Handling of Sewage Sludge," by George S. Webster; "Training for the Municipal Service in Germany," by C. L. King; "A Study of Cleaning Filter Sands with no Opportunity for Bonus Payments," by S. E. Thompson, and "Snow Removals" from a report of the committee on resolutions of the Snow Removal Conference, held last spring in Philadelphia.

Simultaneous with the Public Service meeting on Thursday were sessions on iron and steel and on cement. The papers of the former consisted of "Factors in Hardening Tool Steel," by J. A. Mathews and H. J. Stagg; "Standardization of Chilled Iron Crane Wheels," by F. K. Vial, and "The Mechanical Elimination of Seams in Steel Products, Notably Steel Rails," by R. W. Hunt. Only one paper was presented at the cement section, namely, "Electric Drive for Economic Operation and Development of Cement Mills," by J. B. Porter.

The main social event of the meeting was the dinner-dance held in the grand ballroom of the Hotel Astor, Thursday evening. The dinner was a novelty, being a progressive one, in which the couples moved from table to table at the end of each course, and in each interval between the courses there were three dances. Dancing continued after the end of the dinner. The affair was a marked success, showing that the innovation was appreciated. Heretofore the Reunion, as this evening's affair is designated, has taken the form of a dinner or a dance, but this year they were combined.

*This paper will be abstracted more fully in a later issue.

FRIDAY

The first paper of the Friday morning session, by H. C. Hayes, described a new type of rate flow meter which operates in accordance with the relation connecting the flow and the resulting difference in pressure between the surface and the axis of a spiral vortex. The meter is as simple as the venturi or pitot forms, consisting of a cylindrical chamber terminating in a cone at one end, with the other end capped. The fluid enters through a tangential inlet, thus imparting a vortical motion to the contents of the chamber, and leaves through an axial outlet into which the cone terminates. The low-pressure tap is taken out through the center of the top cap and the high-pressure tap through the side of the chamber. There are no moving parts.

"A Laboratory for Testing and Investigating Liquid Flow Meters of Large Capacity," by W. S. Giele, was the next paper, which was followed by the description of a "New Volume Regulator for Air Compressors," by Ragnar Wikander. This regulates the amount of intake air for air compressors with automatic or poppet type of valves. In order to decrease the amount of intake air, the suction valves are kept open by force during a part of each discharge period, thereby allowing part of the air which has been drawn into the cylinder during the suction period to return through the valves, which close as soon as the amount of intake air remaining in the cylinder has decreased so as to correspond to the amount of compressed air required at the time.

The next paper was by P. F. Walker, on "Physical Laws of Methane Gas," which was followed by a discussion of the "Clinkering Properties of Coal," by L. S. Marks. This as well as the concluding paper of the session, "Damages for Loss of Water Power," by F. W. Dean, will be treated more fully in a later issue.

James Hartness

James Hartness, president of the American Society of Mechanical Engineers for the year 1914, was born in Schenectady, N. Y., in 1861. The first twenty years of his life were spent at Cleveland, Ohio, where after graduating from the public schools he began practical work in machinery building plants. For the next three years he held a position as foreman of a manufacturing plant in Winsted, Conn., and for the four years following was with a hardware manufacturing plant in Torrington, Conn., where he finally served as inventor.

JAMES HARTNESS, RETIRING PRESIDENT OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

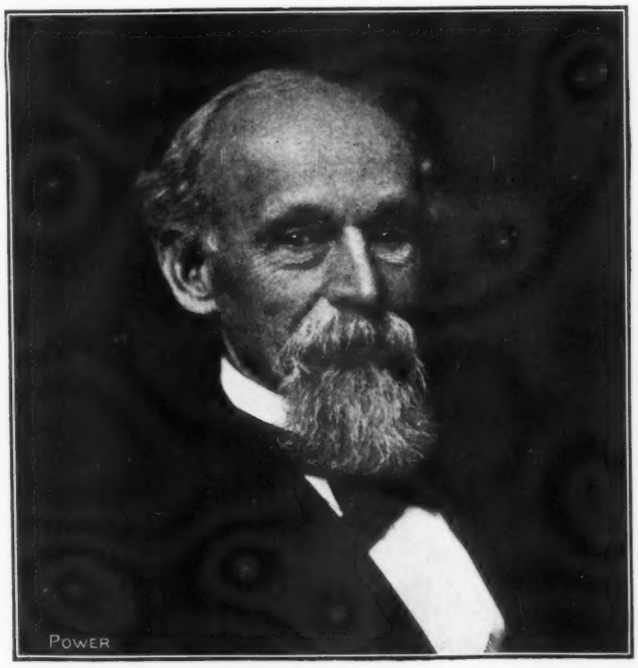
In the fall of 1888. Mr. Hartness designed machinery for the Jones & Lamson Machine Co. at Springfield, Vt., and shortly afterward took an active part in the management of this company. He served successively as superintendent. manager and, for the last dozen years, as president. During this period he has become one of the most prominent manufacturers in New England and one of the most widely known engineers in the country, particularly in the machinery building industry, through the invention and manufacture of the flat turret lathe and of various other machines and tools for turning metal.

In 1910 he invented the turret equatorial telescope, designed to protect the astronomer from the rigors of a cold winter climate. One of these instruments was built, and erected at his residence at Springfield, Vt., and formed the subject of a paper before the Society at the annual meeting of 1910.

Mr. Hartness became a member of the American Society of Mechanical Engineers in 1891. He is a fellow of the American Association for the Advancement of Science, and a member of the Institution of Mechanical Engineers, the Verein deutscher Ingenieure, the Astronomical and Astrophysical Society of America, the London Astronomical Society, the Royal Arts Society, the Boston Chamber of Commerce, and is a vice-president of the Western New England Chamber of Commerce. He was granted an honorary degree of M. E. by the University of Vermont in 1910.

John A. Brashear

John A. Brashear, the newly elected president of the American Society of Mechanical Engineers, is known throughout the world as a manufacturer of astronomical and physical instruments. He was born in Brownsville, Penn., in 1840, and received what little formal education he had in the public schools. After learning the trade of patternmaking, at the age of twenty-two he was established, apparently for life, as a millwright in a Pittsburgh rolling mill.



DR. JOHN A. BRASHEAR, PRESIDENT-ELECT OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

But he was not content to work only for his bread and butter. He and his ambitious young wife spent their evenings studying astronomy. Having no money to buy a telescope they made one for themselves. Their first glass, a five-inch one, took three years to grind. Unsatisfied with its limitations, they set to work on a twelve-inch glass, only to have it break in the silvering process after two years of grinding and correcting. The next glass proved successful, and was the turning point in young Brashear's career. Langley, then in charge of the Allegheny Observatory, began to entrust him with some of the observatory instruments. At the same time, certain astronomical articles which Brashear had written attracted the attention of William Thaw, one of the patrons of the observatory, and he advanced the capital so that Brashear might move to Allegheny and set up a shop there.

Brashear's greatest work in the field of science began with this move to Allegheny. An account of the accomplishments of his shop would be a history of modern astronomy. Perhaps his most important achievement has been in connection with the design and development of the spectroscope for astronomical uses, particularly with reference to the mechanical features.

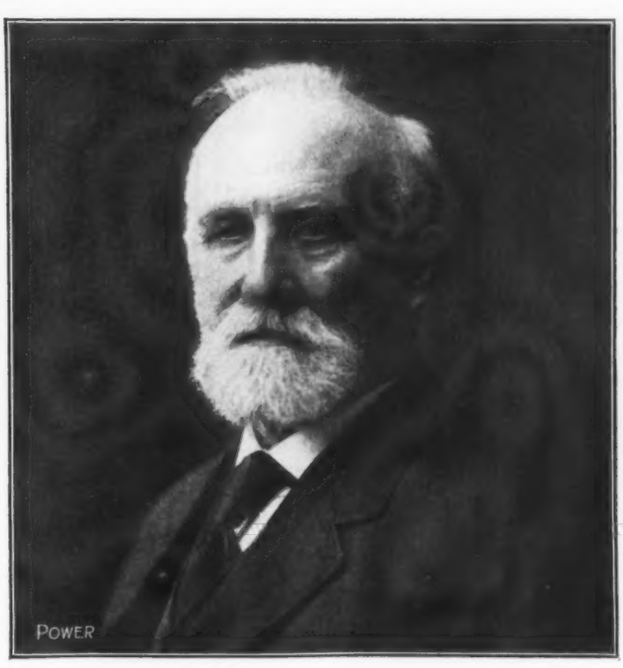
Mr. Brashear's more purely scientific work also brought recognition, and about the time of his removal to Allegheny he was given an appointment in the University of Western Pennsylvania of which the Allegheny Observatory was a department.

The John A. Brashear Company, Ltd., which Dr. Brashear formed with his son-in-law, James B. McDowell, in Allegheny, has been devoted to the construction of apparatus for special work, rather than more commercially profitable products. The firm has no patents and no secrets, and whatever it has accomplished it has freely given to the world. The Allegheny Observatory, which has long been Dr. Brashear's special hobby, is also unique, in that it is at the disposal of the public, through lectures and through access to the telescope and other similar means. For a number of years past he has been a trustee of the Carnegie Institute of Technology.

Dr. Brashear acted as director of the Allegheny Observatory from 1898 to 1900. He is a fellow of the American Association for the Advancement of Science and the Royal Astronomical Society of Great Britain; is a past-president of the Engineers Society of Western Pennsylvania and the Pittsburgh Academy of Arts and Sciences; and is a member of the British Astronomical Association, the Société Astronomique de France, the Société Astronomique de Belgique, the American Philosophical Society, the Astronomical and Astrophysical Society of America, the National Geographic Society, and an Honorary Member of the Royal Astronomical Society of Canada. He has been honored with the degree of LL.D. by Washington and Jefferson College and by Wooster University, and with the degree of Sc.D. by Princeton University and the Western University of Pennsylvania.

John Fritz Medal Awarded to John E. Sweet

Dr. Sweet, the recipient of the John Fritz Medal award this year, first became a national figure from his connection with the Sibley College of Mechanic Arts of Cornell University in



DR. JOHN EDSON SWEET, HONORED WITH THE JOHN FRITZ MEDAL AWARD

1873. This lasted only until 1879, but in that time he became prominent for his work in mechanical engineering education, which was then a new thing.

He next turned his attention to improvement in methods of mechanical construction. Combining an appreciation of Whitworth's advanced standards of accuracy with original conceptions of fundamentally correct principles of construction of a kind far surpassing Whitworth's work, he established a school of construction of which the influence has been far reaching. Along with this went an application of art in design—not the art of ornamentation, but that of perfect adaptation to purpose. His Straight-Line engine was an embodiment of these principles.

Dr. Sweet was born Oct. 21, 1832, at Pompey, N. Y., his mechanical talent being an inheritance through his mother. His introduction to mechanical work was through his apprenticeship to the carpenter's trade, from which he developed as a builder and architect. In 1862 he went to Europe and for a time worked in England as a mechanical draftsman. Returning in 1864, the peculiar individuality of his work soon began to manifest itself, his most ambitious production of this period being a typesetting machine which is still preserved at Cornell University. Later, he was engaged in bridge building for Howard Soule, from which work he was drafted to the Cornell shop, where his pioneer work in accurate measurements was done. This with other examples of student workmanship was exhibited at the Centennial Exposition, where it attracted world-wide attention. The Straight-Line Engine Co., with which his name has been identified, was organized soon after leaving the university. It was his suggestion which led to the organization of the American Society of Mechanical Engineers, of which he was the third president.

Refrigerating Engineers Meet

The third annual meeting of the American Society of Refrigerating engineers was held in the Engineering Societies Building, New York City, Nov. 30 and Dec. 1. Three sessions were held on Monday and two on Tuesday. For the two days of the meeting luncheon was served in the Engineers Club, while a fine banquet in the College Room of the Hotel Astor completed the meeting.

In his address, President Henry Torrance urged wider dissemination of refrigeration data, and recommended continued care in admitting new members so as to keep the membership on a high professional standard.

The new Journal of the society, introduced at this meeting, consists of 125 pages of the usual 6x9-in. size. It contains four of the papers read at the meeting and has a review section of twenty-one pages. There was considerable discussion as to whether the Journal should be available to members only or to all who wished it. It was finally agreed that nonmembers might obtain copies through members or a publisher. The price to be charged will be fixed by the council.

During the year the fire prevention bureau of the fire department of New York began revising its regulations applying to various businesses and industries, and invited the society to appoint a committee to confer with it in the revision of its regulations applying to ammonia and other refrigerants. Revision was completed and the regulations (see this issue, page 862) will go into effect on Jan. 1, 1915.

The second section of the regulations requires that a plant shall have a pipe or pipes by which lines under pressure may discharge into water or conduct the gases to a point not less than ten feet above the roofs of adjacent buildings.

F. L. Fairbanks, of the Quincy Market Cold Storage & Warehouse Co., Boston, who is assisting the Massachusetts Board of Boiler Rules in formulating regulations similar to those of the New York fire department, commented on this section. His argument was that in most plants it is not practically possible to comply with the section, for it requires a considerable body of water to absorb ammonia discharged in case of severe accident. Unless the body of water were a harbor or a river it would soon become saturated and useless as an absorbent. He pointed out that a body of ammonia gas has the peculiar property of remaining intact when floating over a wide area. This was demonstrated to him, when, owing to a break in a 6-in. suction line in the Sargent's Wharf plant* at Atlantic and Eastern Aves., Boston, several families were driven out of their homes in East Boston, across the harbor from the plant. Therefore, the discharge of much ammonia near open windows of adjacent buildings would be decidedly dangerous.

Mr. Fairbanks cautioned against agreeing to the third section of the regulations, which says: "All refrigerating machines shall be equipped with automatic safety devices (meaning safety valves, chiefly) which discharge at 300-lb. pressure for ammonia, 1400 lb. for carbon dioxide, 100 lb. for sulphur dioxide, and 100 lb. for ethyl chloride. He stated that, to begin with, he had every reason to believe that there was not a tight safety valve for ammonia on the market.

Therefore, the use of safety valves that leak frequently leads the engineer to plug them to avoid a loss of part of the ammonia charge. Again, the Massachusetts Board of Boiler Rules had demonstrated in Mr. Fairbanks' plant that the pop type of safety valve so suddenly liberates ammonia gas that there is little likelihood of persons getting out of the room into which the gases are discharged. This board, Mr. Fairbanks said, will not permit, on ammonia compressor heads, the use of safety valves set to blow at 400 lb. into a pipe having a safety valve set at 200 lb. and discharging into a receiver. The question of the disposition of escaping ammonia gases and of safety valves is so serious that the board has not yet solved it. After hearing this report, President Tor-

*For description of this plant see "Power," Dec. 8, 15, 22, 29 and Jan. 1.

BANQUET OF THE AMERICAN SOCIETY OF REFRIGERATING ENGINEERS

rance continued the New York committee and added the name of Mr. Fairbanks inasmuch as his experience showed that the refrigerant regulations of New York City's fire prevention bureau had serious shortcomings. In view of this it would seem that New York City would do well to coöperate with the Massachusetts Board of Boiler Rules. We editorially comment on this on page 849 of this issue.

The committee under Dr. Dannenbaum, of Philadelphia, formed to investigate the sources and compositions of foreign gases in refrigerating systems made a preliminary report. In several cases analyses of the gases showed them to contain from 91 to 95 per cent. nitrogen, the balance being oxygen. That the presence of much of the foreign gases is due to the volatilization of the lubricating oils is shown by the fact that the committee was not able to find a natural American oil that would not crack at commercial compressor temperatures. One Russian oil subjected to temperatures higher than met in practice could not be made to crack.

In this connection it is interesting to note that one eminent authority has stated, not publicly, that tests of this nature—i.e., where the oils are subjected chiefly to a heat test to indicate characteristics of volatilization—may not lead to accurate conclusions, for the tests do not consider the effect of impact of the oil at each stroke. The Bureau of Standards is coöperating with this committee, and it is hoped that next year a valuable and interesting report will be presented. Relative to the cold tests of oils, some oil companies, or at least the Standard Oil Co., is removing the wax from paraffin-base oil by first cooling it, and while at —10, —20, or —30 deg. F., squeezing out the wax. In other words, what nature has done in Russia the Standard Oil Co. is endeavoring to do here.

President Torrance read a short paper on ammonia condensers, but was justly censured for not having been thorough enough in his tests. The paper on ammonia condensers by Fred Ophüls, of New York City, was thorough and scientific. It should be noted, however, that Mr. Ophüls' purpose was to stimulate investigation into the causes that affect the efficiency of ammonia condensers, by stating test results and by giving theoretical deductions, the latter requiring further consideration for accuracy before acceptance.

Unfortunately, it is the practice in the society to read papers, even though they are already published in the Journal, instead of reading abstracts only, so Mr. Ophüls' paper was not discussed, because the reading of it used all the time available.

The objection to reading the entire paper was even more pronounced when the excellent paper on cooling towers by B. H. Coffey and George A. Horne was presented. Relative to the important problems in meteorology and engineering involving the humidity of climates and the evaporation losses in reservoirs and lakes, the subject was shown to be not only extremely complex, but that a suitable mathematical expression for evaporation to the atmosphere was still lacking despite the fact that the bibliography comprises more than eight hundred publications, dating from 1670 to the present.

Mr. Coffey told how ice is formed under peculiar conditions in India in places near the Himalayas. A pit two feet deep is filled with rice straw to within six inches of the top. On top of the straw cups of water are placed. With an atmospheric temperature of 50 deg. or less, and when a north-northwest wind or one coming from the mountains blows, ice forms. But with much lower atmospheric temperatures and other wind directions ice cannot be made to form. The air from the mountains is low in humidity and as the tops of the cups are six inches below the ground surface, a blanket of dry air is present. The evaporation of this water to that air is rapid enough to cause freezing.

A paper by R. S. Broas, of New York City, on rotary compressors for refrigeration was then read. Mr. Fairbanks found that with most compressors built on the design of the Kinney pump serious shocks were produced owing to the unbalance due to the "long side" of the cam-shaped rotor. He overcame this to some extent by extending the shaft and mounting on it another rotor outside the casing and with its "long side" opposite that of the other rotor.

Mr. Shipley, of the York Manufacturing Co., said that his company had tried out in its testing plant all available rotary compressors, but found none that was commercially applicable to general ammonia compression. It was the general opinion of those present that rotary compressors were unsuited to any but low-pressure service, such as booster work.

The last and most interesting paper read was by F. L. Fairbanks, who took as his subject the design, construction and operation of a 1000-ton ammonia compressor. As this machine, as well as all of the important engineering practice in Mr. Fairbanks' plant, is described in a series of articles in "Power" for Dec. 8, 15, 22, 29, 1914, and Jan. 5, 1915, we refer the reader to them.

So much time was consumed with the reading of papers that there was little topical discussion, often so valuable. An interesting one was given by Dr. F. W. Frerichs, of St. Louis, on the manufacture of cylinders for shipment of ammonia.

That well known happy toastmaster, Theodore O. Vilter, of Milwaukee, presided at the banquet. Among the speakers were Louis Block, inventor of the Block condenser; John E. Starr, Thomas Shipley, Prof. C. E. Lucke, of Columbia University and Mr. Freeman, of Boston. Prof. Lucke drew the fire of Mr. Starr by charging refrigeration engineers with little or no progress in extending the application of refrigeration to the industries. The professor was severe in his criticism. Mr. Starr, in defense of the art, mentioned the Eastman Kodak Co., of Rochester, N. Y., as one noteworthy example of the application of refrigeration. He stated that an advance had been made in the amount of ice produced per ton of coal. A few years ago it was but six and seven; today it is twenty and more. Then too there is the application of refrigeration to metallurgy, the paraffin industry, cooling of magazines aboard warships, cooling of batteries in submarines, etc.

The fourth Western meeting of the society will be held in San Francisco, 1915, concurrent with the International Engineering Congress.

Louis Doelling, president of the De La Vergne Machine Co., was elected president; Ezra Frick, vice-president; George A. Horne was retained as treasurer.

California Agreement on Water Power Development of National Forests

The Secretary of Agriculture and the state water commission of California have entered into a coöperative agreement for the use of water-powers within the national forests of that state. It is announced that questions which have been pending for some time are effectually settled by this agreement.

The district forester at San Francisco, mentioned in the paper, is the field officer of the forest service who has charge of the administration of the federal forests in California.

The agreement follows in full:

For the purpose of facilitating the approval of applications for water rights and for the occupancy and use of national forest land within the state of California for the development of water-power, and in order that uniform action may be taken with respect to such applications, the Secretary of the United States Department of Agriculture and the water commission of the state of California, subscribe to the following coöperative agreement:

1. Whenever an application for either a preliminary or a final permit for a water-power site is filed with the district forester at San Francisco, Calif., and the evidence of the appropriation of water consists of a notice posted in conformity with the provisions of Section 1415 of the Civil Code of California, immediate notice of such application for a permit, consisting of the name of the applicant, the name of the stream from which the water is to be diverted, the point of the proposed diversion, the date of the notice, and the name of the locator, shall be sent to the State Water Commission.

2. Whenever an application for a preliminary or a final permit is filed with the district forester, and the evidence of the appropriation of water consists of a copy of an application made to the state water commission, or a permit from said commission under the existing Water Power act, it will be sufficient to inform the commission that such application for permit has been filed with the district forester.

3. Whenever an application is made to the state water commission for a permit to appropriate water, and the use of such water will in any manner necessitate the occupancy and use of any national forest land, immediate notice of the filing of such application shall be given to the district forester at San Francisco. Such notice shall give the name of the applicant, the stream from which the diversion is to be made, the point of the proposed diversion, the date of the notice, the name of the locator, and a description of the lands that may be within such national forest.

4. No application for a water right involving the use of national forest lands will be approved by the state water commission prior to notification by the district forester that a complete application (with the exception of evidence of water appropriation) for the use of the national forest lands has been filed in conformity with the regulations of the Secretary of Agriculture.

5. If the application filed with the district forester, as provided in paragraph 4 hereof, is for a preliminary permit, the state water commission will defer final approval of any application for water right until notified by the district forester that a complete final application (with the exception of evidence of water appropriation) has been filed in accordance with the regulations of the Secretary of Agriculture, or that a preliminary permit containing permission to do construction work has been issued. The district forester will confer with the state water commission before arranging the terms of any preliminary permit and will furnish the commission with copies of such permits immediately upon their issuance.

6. If the evidence of the appropriation of water filed with an application for a final permit for a water power site consists of a notice posted in conformity with the provisions of Section 1415 of the Civil Code of California, such permit will not be issued until the state water commission either ap-

proves such appropriation or disclaims jurisdiction. If the applicant relies upon an appropriation under existing law, no final permit will be issued until notice of the approval of the commission has been filed with the district forester.

7. No preliminary permit will allow construction upon national forest land except in an emergency or to comply with the state law, and then only upon approval of the state water commission.

8. If the time for beginning and completing construction under any final permit issued by the Secretary of Agriculture is different from that granted by the state water commission such difference shall not be deemed to affect in any way the permittee's liability under the state law or the approval of the commission, or to free him from the cancellation of his permit if he loses his water right under the state law.

9. If any permittee shall lose his water right because of failure to begin construction in accordance with the requirements of the state law and of the approval of the state water commission, such loss of right when certified to by the said commission shall be deemed sufficient cause for revocation of the permit.

10. If either the district forester or the state water commission shall fail to give notification of any action as contemplated herein, within sixty (60) days of the receipt of written report of applications pending, the officer or office so reporting may take action without waiting further for such notification.

In witness whereof, this coöperative agreement has been executed at San Francisco, Calif., by the state water commission of California, on the twenty-seventh day of August, 1914, and at Washington, D. C., by the Secretary of the United States Department of Agriculture, on the fourteenth day of November, 1914. (Signed) Charles D. Marx, Harold S. Power, S. C. Graham, D. F. Houston, Secretary of Agriculture.

Bill to Create Federal Safety Bureau

The proposed legislation to create a Bureau of Labor Safety in the Department of Labor was held up at the last session of Congress by objection, by Senator Smoot of Utah, to unanimous consent to consider the bill. The bill is still on the calendar and will likely come up for final action early in January, but if not acted upon before March 4, it will expire by limitation.

The act would provide authority and means, under the jurisdiction of the Secretary of Labor, to make general and special investigations of safety plans and devices of all kinds and the need therefor, and to gather, publish and supply useful information concerning the use of labor safety devices, etc., in the industries of the United States and elsewhere.

A museum and laboratory are provided for wherein shall be exhibited and tested types of guards, etc., for machinery calculated to safeguard employees and the public from injury. It is so drawn and amended as not to conflict with the work of the Bureau of Mines in the matter of mine safety.

Recent Court Decisions

Digested by A. L. H. STREET

Power Plant Employees as "Fellow Servants"—An employer of a fireman and a coal passer is not liable for damages in a suit for injury to the latter caused by negligence of the former, if the fireman bore a relationship of co-employee to the coal passer, and was not in a position of superintendence over him. (New York Supreme Court, First Appellate Division; Fearon vs. New York Life Ins. Co.; 147 "New York Supplement," 644.)

Extent of Water Power Rights—A conveyance of one tract of land together with water rights and water power privileges in an adjoining tract, as appurtenant to the land conveyed, does not entitle the grantee to use such rights and privileges for the benefit of other land owned by him. This is the gist of the Georgia Supreme Court's decision in the recent case of Central Georgia Power Co. vs. Cornell, 82 "Southeastern Reporter," 243.

Removal of Boiler Inspectors—In an opinion recently given by the attorney general of Minnesota he holds that the governor may remove a boiler inspector at pleasure. Under a recent re-apportionment of the state an inspector was eliminated, and in making a new appointment commission was issued by mistake to William Mitroth, instead of H. E. Olson, the governor's choice. Mitroth refused to resign when the mistake was discovered and the Governor's office called upon the attorney general for an opinion, with the result above mentioned.

Damages Recoverable for Personal Injury—Twelve thousand five hundred dollars is not excessive recovery for injury to a stationary engineer, whose arm and muscles and flesh over his ribs were torn off by being caught in a rapidly revolving pulley while he was applying treatment to the pulley to make the belt cling, if the employer had elected not to be governed by the Workmen's Compensation Act, and negligently failed to take steps to reasonably guard the belt. (Wisconsin Supreme Court, Mayhew vs. Wisconsin Zinc Co., 147 "Northwestern Reporter," 1035.)

Breach of Contract to Supply Water—Where a seller of land agreed to furnish from a water-power plant owned by him a supply of water for use by the purchaser of the land, so long as the purchaser should require it, and the latter made extensive improvements on the faith of the contract, he was entitled, on the seller's breach of the agreement, to recover the amount of the depreciation in the value of the land resulting from such breach. But the purchaser has no lien against the dam property to secure performance of the contract. (Texas Court of Civil Appeals, Abney vs. Roberts, 166 "Southwestern Reporter," 408.)

OBITUARY

DUNCAN D. RUSSELL

His many friends will be sorry to learn of the death of Duncan D. Russell, treasurer of the James Russell Boiler Works, South Boston, Mass. Mr. Duncan succeeded his father, who established the business, and carried it on successfully for many years, and will himself be succeeded by his son. He was ex-president of the Scots' Charitable Society of Boston, treasurer of the New England Association of Boiler Manufacturers, and stood high in the confidence of his business associates.

MORRIS G. CONDON

Morris G. Condon, president of the firm of H. B. Underwood & Co., who was robbed and then shot in his apartment at the Hotel Adelphia, Philadelphia, Penn., on Nov. 25, died at the Jefferson Hospital on Dec. 3. His death was due to the abdominal wound inflicted by the bandit, who ended his own life when he believed he had been cornered.

With Mr. Condon at the end was his wife, who had been at his bedside in the hospital almost constantly. Two brothers of the murdered man and an associate in business were present.

Mr. Condon was 51 years old and had a residence at North Wales, Penn. He went to the Adelphia to spend the winter with his wife.

ENGINEERING AFFAIRS

The annual entertainment and reception of the Marine Engineers' Beneficial Association No. 33, of New York City, took place on the evening of Dec. 2, at the Lexington Opera House. The hall was tastefully decorated, and the attendance, as usual, was large. Many prominent engineers and supplymen were present. An interesting entertainment preceded the dance.

The Stationary Engineers' Association of Greater New York held its annual entertainment and ball on Saturday evening, Dec. 5, at the Amsterdam Opera House. Although the weather was unpleasant, the attendance was good. There was a vaudeville entertainment, and dancing concluded the night's enjoyment. The officers of the organization are: John J. Burns, president; Patrick Cody, vice-president; Joseph Cassidy, recording secretary; W. H. Fletcher, financial secretary; Timothy McGarry, treasurer.

The annual mask and civic ball of the Brooklyn Association No. 56, International Union of Steam and Operating Engineers, was held at the Brooklyn Labor Lyceum, Saturday evening, Dec. 5. There was a long program of dances, and many pretty and unique costumes were shown by the participants. The officers are: Frank Schmitz, president; Charles Schneider, vice-president; Norman C. Ames, recording secretary; Ellsworth Stout, corresponding secretary; George Kurz, conductor; Thomas Sugden, guard; H. Greve, treasurer; C. F. Liebman, organizer; Joseph Muntefering, business agent.

Kneiser Association No. 3, N. A. S. E., has unanimously endorsed Oscar F. Rabbe for the position of chief examiner of steam engineers of Ohio. The association states that "We feel that Brother Rabbe is well qualified for the position. He has for many years been a hard worker and a good booster for the N. A. S. E. as well as for the engineers' examination and boiler inspection legislation, and we hope that other local associations will give him their support also."